N61331.AR.001408
NSA PANAMA CITY
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REMEDIAL ACTION PLAN FACILITY 325 NSA PANAMA CITY FL

5/1/1996

ABB

REMEDIAL ACTION PLAN

FACILITY 325

COASTAL SYSTEMS STATION PANAMA CITY
PANAMA CITY, FLORIDA

UNIT IDENTIFICATION CODE: N61331
CONTRACT NO. N62467-89-D-0317/011

MAY 1996

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

ABB

May 20, 1996 Document No. 7520.103

Mr. Eric Nuzie
Federal Facilities Coordinator
Florida Department of Environmental Protection
Twin Towers Building
2600 Blair Stone Road
Tallahassee, Fl. 32399-2400

Subject: **Submittal of the Facility 325 Remedial Action Plan**
Coastal Systems Station (CSS), Panama City
Panama City, Florida.
Contract #N62467-89-D-0317, CTO No. 011.

Dear Mr. Nuzie:

Please find attached two copies of the Remedial Action Plan for Facility 325, CSS Panama City. Two copies have been sent to Nick Ugolini at Southern Division Naval Facilities Engineering Command in Charleston and two copies have been sent to Arturo McDonald at CSS Panama City. One copy has been sent to Tom Conrad at Bechtel.

Should you have any questions concerning this document please feel free to contact Michael Dunaway or myself.

Sincerely,

ABB ENVIRONMENTAL SERVICES, INC.

Mark C. Diblin

Mark C. Diblin, P.G.
Senior Task Order Manager

GOPI KANCHIBHATLA for

Michael K. Dunaway
Principal Engineer

cc: Gopi Kanchibhatla, ABB-ES
Nick Ugolini, EIC, SouthDiv
Arturo McDonald, CSS Panama City
John Mitchell, RPM, FDEP
Greg Brown, P.E., FDEP
Tom Conrad, Bechtel
File

REMEDIAL ACTION PLAN CHECKLIST

Bureau of Waste Cleanup
Florida Department of Environmental Protection

Facility Name: Coastal Systems Station, Facility 325, Panama City **Reimbursement Site:** [ ]

Location: Panama City, Florida **State Contract Site:** [ ]

FAC ID No.: ______

Reviewer: ______ **Date:** May 20, 1996 **Consultant:** ABB Environmental Services, Inc

Date of CAR Approval: February 1996

This checklist should not be applied in blanket fashion. Technical judgement may be necessary in determining the applicability of some items. However, all information listed that is relevant to the remedial design should be provided.

PAGE(S) I. GENERAL

PAGE(S)		
8-1	(1)	RAP signed, sealed, and dated by Florida P.E. (per FS 471.025)
NA	(2)	indication whether proposed plan is for reimbursement program or state contracted cleanup
2-3	(3)	recap of CAR information and conclusions pertinent to RAP preparation
3-3		a) horizontal and vertical extent of contamination in soil and groundwater
3-3		b) volumes of affected soil and groundwater;
App-A		c) estimated mass of contaminants in soil and groundwater.
2-4		d) depth to water table
2-4		e) groundwater flow direction and gradient
App-C I		f) hydraulic conductivity of aquifer and method of determination
App-C I		g) transmissivity of aquifer and method of determination
App-C I		h) confining layer location
App-C II		i) lithology of site
App-A	(4)	current sampling results (within six (6) months) used for remediation system design
2-2	(5)	latest date underground storage tanks and product lines have tested tight
3-4	(6)	potable water considerations
3-4		a) method of potable water supply to area
Fig 3-5		b) location of private wells in 1/4-mile, and public wells in 1/2-mile radius of site
NA		c) indication whether FDEP district office drinking water program was notified if contaminant groundwater could be expected to reach any public or private water well. Method of notification, person notified, and date.
Fig 3-6	(7)	underground utilities which may enhance contaminant transport shown
App-D II	(8)	cleanup time
NA		a) estimated time of cleanup: groundwater; soil
App-D		b) method used to determine cleanup time

NA (9) fencing treatment area required, unless public access is restricted by institutional controls

NA (10) discussion of required maintenance for proposed equipment, including site visit frequency and special O&M considerations

NA (11) all local, state, and federal permits obtained and conditions stated

NA (12) itemized cost estimate for project: capital, operation, maintenance, sampling, and closure

NA (13) feasibility of leasing equipment considered (cost cannot exceed purchase price)

3-7 (14) alternative analysis or discussion of other alternatives considered

NA (15) cost effective analysis provided if design is innovative

NA (16) statement that signed and sealed as-built drawings to be provided

NA (17) nuisance noise and odor to neighbors avoided by careful location of equipment items and exhaust stacks or other mitigating measures

II. REMOVAL AND/OR REPLACEMENT (R/R) OF PETROLEUM STORAGE SYSTEMS: Technical and Reimbursement Considerations

(1) General

NA a) indication whether R/R will be claimed as reimbursable expense

NA b) acknowledgement that R/R reimbursement is exclusive of hardware

NA c) acknowledgement that any relocation and facility renovation activities during R/R are not reimbursable

NA d) if dewatering involved during R/R, then documentation provided regarding proper disposal, or verification that water not contaminated.

NA e) indication of quantity and location of soil removed, or to be removed, from below the static water table

(2) PRIOR TO JULY 1, 1992: R/R reimbursement justification based on association of contamination with the tank (or tank pit)

NA a) verification of petroleum storage system as potential contamination source by either verified leak, apparent leak, or overlapping when soil and/or groundwater contamination plumes superimposed on a site map showing tank bed

NA b) indication of whether R/R has already been done, or to be done after RAP approval

NA c) proper disposal of water, soil, and sludge from the R/R

2-2 d) scaled site map including:

(1) identification and location of all storage system components to be R/R
(2) boundaries and dimensions of excavation

Yes or No e) FDEP reviewing engineer: Agree that tanks which were subject of R/R were associated with the contamination? If disagree, then include statement in RAP Approval Order, even if tanks already removed

(3) **ON OR AFTER JULY 1, 1992:** R/R reimbursement is based on pertinence of tank removal to the achievement of cleanup criteria set for in 62-770, F.A.C.

NA a) R/R justified as meaningful and necessary for achievement of 62-770 FAC cleanup criteria

NA b) if R/R is part of a RAP Modification, then show cost-effectiveness in comparison to other alternatives and no action

NA c) if R/R was done during IRA, then discussion of necessity of R/R in order to remove contaminated soil and/or free product

NA d) if R/R is associated with a MO or NFA, then show that the removal of soil, product, and groundwater contributes or contributed to achieving MO or NFA criteria

Yes or No e) FDEP reviewing engineer: Agree that R/R contributed (or will contribute) in a meaningful way to site cleanup? If disagree, then include statement in RAP Approval Order even if tanks already removed

III. FREE PRODUCT REMOVAL

Fig 3-1 (1) free product plume identification

4-1-1 (2) description of free product recovery system

NA (3) oil/water separator sizing calculations and detention time

NA (4) free product storage tank of adequate size for reasonable maintenance

NA (5) automated product pump shutdown for high level in product tank

NA (6) disposition free product after its recovery

IV. SOIL REMEDIATION - GENERAL

App-A II (1) volumes of all contaminated and excessively contaminated soils

App-B (2) recap of IRA activities and soil volume already excavated

NA (3) effect of soil leachate from non-excessively contaminated soils on groundwater contaminant levels evaluated

3-6 (4) indication that excessively contaminated soils (per soil guidance manual) will be remediated, or rationale for "no action" alternative for soil remediation provided

NA (5) disposition of excavated, contaminated soils

NA (6) indication that hazardous soils (e.g., ignitable, corrosive, reactive, toxic, or petroleum refining waste) will be disposed of properly

V. LAND FARMING OF SOIL

NA (1) adequate surface area available (________ sq ft) to spread soils 6 to 12 inches thick

NA (2) location of landfarming operation

NA (3) landfarming area is flat (less than 5% slope)

NA (4) impermeable base provided. Type:

NA (5) surface water runoff controls provided

NA (6) groundwater monitoring plan proposed if landfarm is outside of immediate contamination area

NA (7) frequency of tilling provided

NA (8) frequency and details of nutrient application or other enhancements provided (if proposed)

NA (9) soil sampling frequency and sampling methods provided

NA (10) potential for land farm causing nuisance conditions evaluated

NA (11) underlying soil and groundwater monitoring procedures provided and acceptable

NA (12) landfarming will be continued until the TRPH concentration is 10 ppm or less (by EPA Method 9073) and the BTEX concentration is less than 100 ppb (by EPA method 5030/8020); or TRPH concentration is 50 ppm or less, and PAH concentration is 1 ppm or less, and VOH concentration is 50 ppb or less. Alternate TRPH standard may be considered if appropriate and acceptable means of soil disposal is identified.

NA (13) cost-effectiveness evaluated

NA (14) ultimate disposition of soils discussed

NA (15) need to fence landfarm area considered

VI. LANDFILLING OF SOILS

NA (1) landfill lined permitted by FDEP

NA (2) name and location of landfill provided along with conditions of acceptance

NA (3) cost-effectiveness considerations

VII. SOIL THERMAL TREATMENT

NA (1) name and location of thermal treatment facility provided

NA (2) facility is permitted for thermal treatment of petroleum contaminated soils

NA (3) indication of whether pretreatment soil samples will be collected at site or at thermal treatment facility

NA (4) cost-effectiveness evaluation

VIII. COMMERCIAL BIOREMEDIATION OF SOIL

NA (1) name and location of bioremediation facility provided

NA (2) facility is permitted for bioremediation of petroleum contaminated soils

NA (3) indication of whether pretreatment soil samples will be collected at site or at bioremediation facility

NA (4) cost-effectiveness evaluation

IX. IN SITU BIOVENTING OF SOIL

NA (1) soil cleanup criteria identification

NA (2) estimated mass of contaminants in the vadose

NA (3) pilot test determination of: a) soil temperature, permeability, pH, moisture, b) nutrient requirements; c) presence of suitable indigenous microbes; and d) oxygen requirement (usually as pounds of air to pound of hydrocarbon degraded)

NA (4) layout: a) location of air injection and air extraction and wells with respect to contaminated soil plume location and depth; b) location and depth of soil gas monitoring probes with respect to contaminated soil plume and the air injection and extraction wells.

NA (5) mechanical details, equipment sizing calculations, and operating parameters: a) well type - vertical or horizontal; b) well construction details; c) indication whether soil vacuum pump will be used alone (with induced influx of air from unsealed surface acting as oxygen source) or accompanied by air injection pump as oxygen source; d) vacuum pump/blower specifications and horsepower; e) method and design details of moisture addition if site soils are dry; e) method and design details of nutrient delivery system, if necessary

NA (6) estimated cleanup time

NA (7) instruments, controls, gauges, and valves: a) subsurface soil gas monitoring probes; b) pressure gauges; c) shutoff/throttling valves; d) nutrient and moisture addition control devices and meters

NA (8) monitoring plan: CO_2; pertinent bioremediation parameters; contaminants of concern.

NA (9) air emissions: a) generally, no air emissions treatment necessary because vapor flow rates are so low and biodegradation of petroleum results in production of CO_2 and water; b) evaluation of need for offgas treatment if pilot test indicated that a significant amount of coincidental hydrocarbon volatization occurs.

X. SOIL VACUUM EXTRACTION

4-1-1 (1) Prerequisites

YES a) relatively permeable soil

YES b) depth to groundwater > 3 ft

YES c) relatively volatile contaminants

(2) Pilot study (results of onsite testing, unless pilot study approaches size of full-scale system)

NA a) pilot test components designed and located for cost-effective subsequent integration into full-scale design

NA b) diagram of pilot layout indicating location of vapor extraction well, and radial distance of monitoring wells from the vapor extraction well

NA c) air flow, cfm

NA d) radius of influence, ft; vacuum (inches of water) at limit of radius of influence

NA e) water elevations at monitoring wells to assess groundwater mounding; observed mound, inches

NA f) vacuum readings at monitoring wells and at various radial distances from extraction well to aid in full-scale design

NA g) measurement of offgas contaminant concentrations for the purpose of selecting and sizing cost-effective offgas treatment for full-scale system

NA h) determination of soil's permeability (Rule of thumb): permeability should be greater than 10^{-9} sq cm)

(3) Full-scale design

Fig 4-3 a) location(s) and radius of influence, ft; overlapping radii for adequate coverage of excessively contaminated soil plume

Fig 4-4 b) vapor extraction well(s) construction details

4-1-2 1) no. of wells; cfm ea well; total cfm; well type (vertical or horizontal); well diameter; well depth; water table (ft bls); screen slot size; screened interval (ft bls); well sealed w/bentonite or non-shrinking grout at screen design depth to prevent short-circuiting.

4-1-2 2) screen location close to water table to optimize collection of vapors across vadose depth but not so close as to collect excessive water

4-1-2 c) operating vacuum @ wellhead(s), inches water

1) calculation of piping system friction losses

2) calculation of vacuum pump motor hp based on system losses plus required vacuum at wellhead

4-1-2 d) vacuum source type; regenerative blower; positive displacement vacuum pump; other

App-D I 1) design: cfm @ inches water; operating cfm @ inches water

App-D I 2) mfgr; model; motor hp; rpm; performance curves; hp calculations or curves

App-D I 3) nonferrous materials of construction and/or assembly to minimize potential for sparking and friction

App-D I 4) explosion proof motor specified

4-1-1 e) moisture separator/condensation trap ("knock out pot") prior to inlet of vacuum pump

App-D VII f) surface sealing provided for vacuum extraction, or existing concrete or asphalt adequate

NA g) safety:

NA 1) system operation at approximately 25% of Lower Explosive Limit (LEL)

NA 2) bleed valve to control flammable vapor concentrations

Fig 4-5 h) instrumentation, gauges, and appurtenances:

NA 1) vacuum gauges at each well; temperature gauges (@ vacuum pump and/or exhaust gas stack)

NA 2) sample ports for influent from each well, and for the offgas from the treatment unit

NA 3) air flow control: shout/throttling valve at each well; other air flow control device or method

NA 4) high level switch in knock out pot to either shut down vacuum pump or drain the pot (w/proper disposal of the contaminated water)

App D-II i) air emissions (general):

App D-II 1) expected concentrations and quantities of any contaminants discharged to air

App D-VI 2) method of cost-effective offgas treatment to be provided during first two months of system operation (Provide details in Section XI or XII for carbon adsorption or thermal oxidation of offgas, or details of any alternate method proposed)

4-6 j) system monitoring proposal provided:

4-6 1) air emissions to be sampled and analyzed monthly per Department guidance

3-1 2) soil cleanup criteria provided

4-1-1 3) provision for monitoring wells to serve as vacuum measurement locations (at various radial distances from extraction wells), or other provisions for verification of proper operation

XI. VAPOR-PHASE CARBON ADSORPTION (for control of air emissions)

NA (1) Cost-effectiveness evaluation in comparison to other alternatives.

App D-VI (2) Mechanical details, sizing calculations, and operating parameters: a) gas flow rate; b) gas temperature; c) effect of moisture level on adsorption; d) identification of contaminants; e) contaminant concentrations; f) retention (expressed as a percent or pounds of contaminant adsorbed per pound of carbon); g) carbon usage rate; h) configuration of carbon vessels in series; i) pressure drop; j) pressure relief valve for carbon vessels; k) proper disposal/regeneration and replacement of spent carbon.

Fig 4-5 (3) Instrumentation, controls, gauges, and valves: a) high pressure shutdown switch and pressure relief valve; b) pressure gauges; c) temperature gauges; d) sampling ports

7.0 (4) Safety: a) evaluation of need to isolate carbon units from other equipment items in the process train by an in-line flame arrestor; b) identification of the Lower Explosive Limit (LEL) for contaminants; c) observance of appropriate requirements in Series 500 articles of the National Electrical Code - equipment shall meet either Class I, Group D, Division 1 or Class I, Group D, Division 2 hazardous area requirements, whichever is applicable when an equipment item is located in a hazardous area as defined by the code.

XII. THERMAL/CATALYTIC OXIDATION (for control of air emissions)

NA (1) Cost-effectiveness evaluation in comparison to other alternatives.

NA (2) Mechanical details, equipment sizing calculations, and operating parameters: a) type - thermal or catalytic; b) combustion air flow rate; c) supplemental fuel type - propane or natural gas; d) temperature and retention time; e) stack height; f) stack diameter.

NA (3) Instrumentation, controls, gauges, and valves: Schematic or mobile unit manufacturer's drawings indicating instrumentation, controls, gauges, and valves for all process streams (contaminant-laden influent, fuel gas, and combustion air).

NA (4) Safety considerations include but are not limited to: a) bleed valve or dilution control valve to maintain influent flammable vapor concentration at 25% of the Lower Explosive Limit (LEL); b) evaluation of whether a flame arrestor should be installed in the pipeline between thermal oxidation unit and a soil vapor vacuum extraction pump which feeds the oxidizer; c) air purge prior to re-ignition; d) observance of appropriate requirements in Series 500 articles of the National Electrical Code - equipment shall meet either Class I, Group D, Division 1 or Class I, Group D, Division 2 hazardous area requirements, whichever is applicable when an equipment item is located in a hazardous area as defined by the code; and e) use of thermal or catalytic oxidizers which meet appropriate fire codes for handling natural or propane gas and prevention of furnace explosions - National Fire Protection Association, Industrial Risk Insurer's, Factory Mutual, etc. Some of the most important safety shutdowns for gas-fired burners occur upon: high gas pressure; low gas pressure; loss of combustion supply air; loss of failure to establish flame; loss of control system actuating energy; and power failure.

XIII. GROUNDWATER EXTRACTION

4-1-2 (1) feasibility of using existing on-site wells for groundwater extraction considered

4-1-2 (2) a) recovery well or trench location(s) and construction details included

b) recovery well depth appropriate for depth of contamination reported in CAR. The recovery well depth should optimize petroleum mass recovery relative to groundwater recovery.

4-1-2 c) well diameter

Table 4-1 d) screening interval appropriate

NA ____ (3) predicted horizontal and vertical area of influence with hydraulic gradient provided

NA ____ (4) expected drawdown in recovery well or trench (_____ft)

NA ____ (5) consideration of multiple well configurations to minimize drawdown

NA ____ (6) groundwater pump(s) description , pump characteristic curve, design flowrate (____gpm at ____ft TDH provided) mfgr; model; motor hp

NA ____ a) hydraulic design (including friction losses and suction lift considerations acceptable

NA ____ (7) automated well level controls provided for stopping/starting groundwater pump(s)

NA ____ (8) totalizing flowmeter installed on influent line from each groundwater recovery pump

NA ____ (9) check valve provided on pump discharge piping if not integral to pump

NA ____ (10) shutoff/throttling valve provided on pump discharge piping

XIV. GROUNDWATER TREATMENT SYSTEM - GENERAL

NA ____ (1) expected or calculated influent concentrations acceptable (based upon pumping test dynamic sample, weighted averaging procedure, or other reasonable assumptions)

NA ____ a) summary of the expected influent concentrations: benzene________; toluene______; ethylbenzene________

xylene________; MTBE________; total naphthalenes________

PAHs ________; EDB________; 1-2 dichloroethane_______

others ____

NA ____ (2) feasibility of discharge to sewage treatment plant evaluated

NA ____ a) consideration given to less time and/or level of treatment required to meet sewage system pretreatment standards

NA ____ (3) site piping plan, and schematics of <u>all</u> treatment components, piping valves, controls and appurtenances provided

NA ____ a) influent and effluent sampling ports provided

NA ____ b) piping type and size provided

NA ____ (4) Iron fouling: a) groundwater analyses: total ____ppm; dissolved____ppm; and b) consideration whether iron fouling should be controlled by filtration of influent to remove particulately-bound iron, and/or by removal or sequestering of dissolved iron to prevent precipitation in process equipment items.

(Generally, "normal" concentration of dissolved iron in water is approx. 0.1 to 0.3 ppm, and unless the pH of the water falls below 5, it rarely exceeds 1 ppm.)

NA ____ (5) Calcium carbonate: Consideration whether pretreatment or other measures necessary to prevent fouling by calcium carbonate (Langalier Index calculation based on groundwater samples may aid in this consideration)

NA ____ (6) need for pretreatment or O&M for biofouling considered

XV. AIR STRIPPING TREATMENT PROCESS

NA ____ (1) Packed Tower:

NA ____ a) type, size, and surface area of packing

NA ____ b) calculations, criteria, design parameters

tower height ; tower diameter
packing height ; water flow rate

air flow rate ; blower hp

air/water ratio ; pressure drop across packing

NA c) pressure gauge to indicate effects of fouling over time

NA d) mist eliminator

NA e) observation port

NA f) O&M considerations (fouling potential)

NA (2) Diffused Aerator (tank type):

a) calculations, parameters (tank volume; contact time, air flowrate, pressure drop, contaminant removal efficiency) and design assumptions

NA (3) Low Profile Air Stripper

NA a) Number of trays; water flow rate; air flow rate; air/water ratio; pressure drop; blower horsepower; mist eliminator;

NA (4) General:

NA a) maximum ambient air impact calculations; emissions stack height

NA b) equipment description if emissions treatment necessary

NA c) automated recovery well shutdown when blower failure occurs

NA d) daily analysis screening with portable GC, or other appropriate measures, during system startup until system consistently meets discharge criteria

XVI. LIQUID-PHASED CARBON ADSORPTION

NA (1) indication whether adsorption is for primary treatment of groundwater or polishing of effluent

NA (2) carbon specifications

NA (3) carbon unit(s) sizing calculations (carbon usage rate, contact time, pressure losses) /design assumptions

NA (4) isotherm data from pilot study needed if carbon adsorption used as primary treatment and total VOA concentrations are appreciable (VOA > 100 ppb typically) in order to estimate carbon capacity required and sampling frequency

NA (5) TOC in groundwater determined and effect on carbon usage considerations

NA (6) need for sand filter or cartridge unit considered prior to carbon unit

NA (7) pressure gauge and pressure relief valve provided on carbon (and sand) filter

NA (8) carbon disposal and replacement method

NA (9) series configuration of carbon units considered to allow for maximum carbon utilization and prevention of contaminant breakthrough to system effluent

NA (10) automated recovery well shutdown if primary carbon unit pressure too high

NA (11) schedule for sampling between and after carbon adsorption units

XVII. IN SITU AIR SPARGING OF GROUNDWATER

4-2 (1) Prerequisites:

4-2 a) No or little free product which could spread via sparge turbulence, or prolong sparging

NA b) Volatile (C3-C10) petroleum fractions with Henry's Constant > = .00001 atm.m^3/mole (approx. rule of thumb, unless biosparging is proposed)

NA c) no high concentrations of metals (iron, magnesium) to form oxides which plug aquifer or well screens, or high concentrations of dissolved calcium, which could react with CO_2 in air to clog aquifer w/calcium carbonate

(Notes: Langelier Index calculation regarding equilibrium between calcium carbonate and dissolved CO_2 may be helpful. Generally, precipitation of dissolved iron is less likely when water is acidic, approx. of pH less than 6.)

(2) Pilot study results

NA (3 stage pilot study recommended prior to RAP design): vapor extraction only; sparging only; combined extraction and sparging

A pilot study is generally necessary, unless plume size is relatively small and aquifer characteristics favorable

NA a) pilot test components designed and located for cost-effective subsequent integration into full-scale design

NA b) diagram of pilot layout indicating locations of air injection well, vapor extraction well, and radial distance of monitoring wells from the air injection well

NA c) air flow rates for each stage: vapor extract, cfm; sparging, cfm; combined cfm

NA d) radius of influence for each stage: vapor extract, ft; sparging, ft; combined ft

NA e) groundwater mounding observed during each stage: vap extract, inches; sparging, inches; combined, inches

NA f) measurement of parameters which are pertinent to full-scale design at various radial distances from the air injection well (for example: vacuum readings, pressure readings, water elevations, dissolved oxygen, pH, and conductivity)

NA g) measurement of vapor extraction system offgas contaminant concentrations for the purpose of selecting and sizing cost-effective offgas treatment for full-scale system

NA h) determination of soil's permeability. (should be greater than 10^{-9} sq cm for sparging to be feasible)

NA i) need for groundwater recovery for plume control evaluated.

(3) Full-scale design

3-3-3 a) groundwater contamination plume coverage:

Fig 4-6 1) location(s) and radius of influence for full-scale air injection well(s); Adequate coverage by overlapping radii of influence if multiple well system

4-1-2 b) air injection well(s): no. of wells; well design; operating air press at wellheads; cfm each well; total cfm ____________

Table 4-1 c) avoidance of long screen allowing air to diffuse at top portion only, where air flow resistance is least (typ screen is 1 to 3 ft lg)

Table 4-1 d) well depth and screened interval (or depth of sparge tip) appropriate w/ respect to depth of contamination ____________

4-1 e) vapor extraction well(s) in conjunction w/sparging situated properly to recover volatiles and prevent their release to atmosphere:

App-D III 1) injection cfm of air typically 20 to 80 % of vapor extraction cfm. (0.2 to 0.8)

4-2 2) automatic shutdown of air injection upon loss or low vapor extraction system vacuum, or failure of vacuum pump motor, in order to prevent air emissions

4-4 3) adequate and cost-effective treatment of vapor extraction system offgas proposed to prevent air emissions

App-D III f) compressor:

design: cfm @ psig; operating cfm @ psig
compressor: type; mfgr; model; motor hp; rpm; performance curves;
air filter at compressor inlet; oil trap or oil-free compressor to avoid introducing more contamination to aquifer

App-D III g) safety: pressure relief valve at discharge of compressor and/or high pressure switch for automatic shutdown

Fig 4-5 h) instrumentation and gauges: pressure indicating gauges at each sparging well

Fig 4-5 i) air flow control: shutoff/throttling valve at each well; other flow control device or method

NA j) cost-effectiveness evaluation of proposed full-scale design includes cost of pilot study

XVIII. IN SITU/ENHANCED BIORECLAMATION

NA (1) groundwater parameters evaluation (pH, DO, TDS, N, P, Temp, TOC, and Alk, etc.)

NA (2) monitoring program discussion. TOC to be monitored

NA (3) additional oxygen source provision

NA (4) oxygen and nutrients method of application and application rate to contaminated area evaluated

NA (5) suitable soils present (non-clayey, good transport, low adsorption properties)

NA (6) bench scale and/or in situ pilot study proposal

XIX. LEAD REMOVAL

NA (1) discussion of area(s) where groundwater lead concentrations exceeds 15 ppb

NA (2) lead concentrations; unfiltered (___ppb); filtered (___ppb); background (___ppb);

NA (3) proposal for lead removal by filtration if unfiltered sample is greater than 15 ppb and filtered sample is less than 15 ppb

NA (4) method of lead removal, including pertinent design calculations

XX. INFILTRATION GALLERY

NA (1) field percolation test (preferably with double ring infiltrometer) provided if gallery base is located in the vadose zone

NA (2) infiltration gallery construction details and location (upgradient location if site layout allows)

NA (3) gallery calculations/assumptions with mounding analysis

NA (4) piezometer and cleanout pipe in gallery

NA (5) geotextile filter fabric to be installed around the above gallery

NA (6) discussion or modeling of gallery's effect on plume migration

XXI. INJECTION WELL

NA (1) discussion of injection zone and relevant lithology information

NA (2) injection well location and proposed construction details

NA (3) screening interval appropriate

NA (4) effluent discharge pump description, pump characteristic curve, and design flow rate (____gpm at ____ft TDH)

NA (5) carbon polishing unit (or equivalent)

NA (6) air release valve at highest point of effluent discharge piping

NA (7) injection rate (well hydraulics) calculations

NA (8) Underground Injection Control (UIC) permit conditions met

NA (9) evaluation of injection well's effect on potable wells and plume migration

XXII. ALTERNATE DISPOSAL METHODS

3-16 (1) cost-effectiveness comparison of alternatives (including general permit fee of $2,500 per year in the cost estimate for NPDES disposal, if it is one of the alternatives being compared)

NA (2) for surface water discharge:

NA ____ a) conditions for NPDES general permit met

NA ____ b) indication that notice of intent for NPDES permit will be submitted after RAP approval

NA ____ (3) if applicable, consumptive use permit obtained from water management district

NA ____ (4) approval from municipality for sewer discharge, and conditions and effluent standards to be met

NA ____ (5) applicable permits for stormwater discharge

XXIII. SAMPLING REQUIREMENTS

4-3 ____ (1) designated monitoring wells and their sampling frequency:

upgradient__________; downgradient__________; highest concentration__________

NA ____ (2) weekly sampling of influent from recovery well(s) and effluent at treatment system for first month, monthly sampling for first year

NA ____ (3) filing of annual status reports acknowledgement

4-3 ____ (4) water table contours and depth and extent of free product to be determined at monthly or quarterly sampling event

3-1 ____ (5) sampling program includes appropriate contaminants/procedures as specified in 62-770.600

NA ____ (6) periodic maintenance and site inspection limited to twice a month for first quarter, monthly thereafter, or justification for alternative frequency provided

DISTRIBUTION

SOUTHNAVFACENGCOM	6
CSS PANAMA CITY	2

REMEDIAL ACTION PLAN

FACILITY 325

COASTAL SYSTEMS STATION, PANAMA CITY

PANAMA CITY, FLORIDA

Contract No. N62467-89-D-0317/011

Unit Identification Code: N61331

Prepared by:

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Tallahassee, Florida 32301

Prepared for:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29418

Nick Ugolini, Code 1843, Engineer-in-Charge

May 1996

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, ABB Environmental Services, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/011 are complete and accurate and comply with all requirements of this contract.

DATE: May 17, 1996

NAME AND TITLE OF CERTIFYING OFFICIAL: Mark Diblin, P.G.
Task Order Manager

NAME AND TITLE OF CERTIFYING OFFICIAL: Michael Dunaway, P.G., P.E.
Project Technical Lead

(DFAR 252.227-7036)

FOREWORD

Subtitle I of the Hazardous and Solid Waste Amendments of 1984 to the Solid Waste Disposal Act of 1965 established a national regulatory program for managing underground storage tanks (USTs) containing hazardous materials, especially petroleum products. Hazardous wastes stored in USTs were already regulated under the Resource Conservation and Recovery Act of 1976. Subtitle I requires that the U.S. Environmental Protection Agency (USEPA) promulgate UST regulations. The program was designed to be administered by individual states, who were allowed to develop more stringent, but not less stringent standards. Local governments were permitted to establish regulatory programs and standards that are more stringent, but not less stringent than either State or Federal regulations. The USEPA UST regulations are found in the Code of Federal Regulations, Title 40, Part 280 (40 Code of Federal Regulations [CFR] 280) (*Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks*) and 40 CFR 281 (*Approval of State Underground Storage Tank Programs*). 40 CFR 280 was revised and published on September 23, 1988, and became effective December 22, 1988.

The Navy's UST program policy is to comply with all Federal, State, and local regulations pertaining to USTs. This report was prepared to satisfy the requirements of Chapter 62-770, Florida Administrative Code (*State Underground Petroleum Environmental Response*) regulations on petroleum contamination in Florida's environment as a result of spills or leaking tanks or pipes.

Questions regarding this report should be addressed to the Commanding Officer, Coastal Systems Station, Panama City, Florida, or to Southern Division, Naval Facilities Engineering Command, Code 1843, at 803-820-5596 (AUTOVON 563-0307).

EXECUTIVE SUMMARY

A Contamination Assessment Report (CAR) for Facility 325 at Coastal Systems Station, Panama City, Florida, was submitted by ABB Environmental Services, Inc. (ABB-ES), in January 1996 to Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM).

The CAR has concluded the following:

- Groundwater contamination at the site appears to be related to releases from the former underground storage tanks (USTs) and associated pipelines. These sources have been removed as part of an initial remedial action (IRA) between July and August 1995.

- Free product at the site is likely associated with one or more previous releases from the UST system. Very little of the free product released at the site was recovered during the UST system removal and subsequent IRA. The free product observed in monitoring well MW-26 on December 22, 1996, is probably part of an isolated pocket in the vadose zone that periodically migrates with water table fluctuations. A monitoring well inspection conducted on April 27, 1996, reported presence of free product in monitoring wells MW-8, MW-9, MW-15, MW-23, and MW-26.

- Excessively contaminated soil at the site will require remediation to meet clean soil standards as outlined in Chapter 62-770, Florida Administrative Code (FAC).

After approval of the CAR by the Florida Department of Environmental Protection in February 1996, ABB-ES was authorized by SOUTHNAVFACENGCOM to develop a remedial action plan (RAP) under contract task order No. 011 of the Comprehensive Long-term Environmental Action, Navy contract. This RAP has been developed to the describe site cleanup. Components of this RAP are as follows:

- vacuum enhanced extraction of free product, and limited extraction of groundwater, treatment of mixed fluids at the oily-waste collection and treatment system;

- vacuum enhanced extraction of soil vapor, and treatment of soil vapor;

- installation of necessary piping for a future potential aquifer air sparging system; and

- groundwater monitoring.

These systems will be operated until the kerosene and mixed products analytical group constituents in both the groundwater and the soil reach the required target concentrations or until further remedial activities are not effective. It is estimated that the operation period will be about 3 years.

ACKNOWLEDGEMENTS

In preparing this report, the underground storage tank personnel at ABB Environmental Services, Inc., commends the support, assistance, and cooperation provided by the personnel at Coastal Systems Station (CSS), in Panama City, Florida, and Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM). In particular, we acknowledge the effort of the following people in the preparation of this report.

NAME	TITLE	POSITION	LOCATION
Nick Ugolini	Environmental Engineer	Engineer-in-Charge	SOUTHNAVFACENGCOM
Mike Clayton	Environmental Coordinator	Environmental Coordinator	CSS, Panama City
Arturo McDonald	Environmental Coordinator	Environmental Coordinator	CSS, Panama City

TABLE OF CONTENTS

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

TABLE OF CONTENTS (Continued)

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

LIST OF FIGURES

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

LIST OF TABLES

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

GLOSSARY

AAS	Aquifer Air Sparging
ABB-ES	ABB Environmental Services, Inc.
atm	atmosphere
BEI	Bechtel Environmental, Inc.
bls	below land surface
CA	Contamination Assessment
CAR	Contamination Assessment Report
°C	Celsius
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cm^2	square centimeters
CSS	Coastal Systems Station
DCA	dichloroethane
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDER	Florida Department of Environmental Regulation
ft^3/min	cubic feet per minute
GAC	granular activated carbon
Hg	mercury
IRA	initial remedial action
JP-5	jet petroleum 5
mg/ℓ	milligrams per liter
MTBE	methyl tert-butyl ether
OVA	organic vapor analyzer
PAH	polynuclear aromatic hydrocarbons
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
RAC	Remedial Action Contract
RAP	Remedial Action Plan
scfm	standard cubic feet per minute
SOUTHNAV-FACENGCOM	Southern Division Naval Facilities Engineering Command
SVE	soil vapor extraction

GLOSSARY (Continued)

TRPH	total recoverable petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
USTs	underground storage tanks
VEE	Vacuum Enhanced Extraction
VEEW	vacuum enhanced extraction wells
VOA	volatile organic aromatics
VOCs	volatile organic compounds

1.0 INTRODUCTION

A Contamination Assessment Report (CAR) for Facility 325 at Coastal Systems Station (CSS), Panama City, Florida, was submitted by ABB Environmental Services, Inc. (ABB-ES), in January 1996 to Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM). After approval of the CAR by the Florida Department of Environmental Protection (FDEP), ABB-ES was authorized by SOUTHNAVFACENGCOM to develop a remedial action plan (RAP). This work is being performed under contract task order No. 011 of the Comprehensive Long-term Environmental Action, Navy contract.

1.1 PURPOSE. The purpose of the RAP is to present a plan for remediation of petroleum contamination at Facility 325. The RAP presented herein is designed for implementation at Facility 325 and, when implemented, will result in compliance with the requirements of Chapters 62-770 and 62-775, Florida Administrative Code (FAC) (FDEP, 1994).

1.2 SCOPE. This RAP presents the rationale for the remedial actions to be implemented at Facility 325. Implementation of remedial actions described in this RAP will include the following tasks:

- vacuum enhanced extraction of free product, and limited extraction of groundwater, treatment of mixed fluids at the oily-waste collection and treatment system;
- vacuum enhanced extraction of soil vapor, and treatment of soil vapor;
- installation of necessary pipes for a future potential aquifer air sparging system; and
- groundwater monitoring.

2.0 BACKGROUND

2.1 SITE DESCRIPTION. The CSS Panama City is a Navy research and development facility located on St. Andrew Bay in Bay County, Florida (see Figure 2-1). It is situated approximately 103 miles east of Pensacola, 98 miles west of Tallahassee, and 7 miles west of Panama City. The CSS Panama City is bounded by U.S. Highway 98 to the north, St. Andrew Bay to the east, State Route 392B (Magnolia Beach Road) to the south, and State Route 392 (Thomas Drive) to the west.

The CSS Panama City consists of two operational areas that encompass 657 acres. The laboratory area, situated north of Alligator Bayou (an inlet to St. Andrew Bay), covers approximately 350 acres and houses research facilities and various support activities and tenants. The ordnance area, south of Alligator Bayou, is approximately 300 acres and is used primarily for ordnance storage and limited research. Facility 325 is located in the laboratory area.

Facility 325 was the location of three 20,000-gallon underground storage tanks (USTs) containing jet petroleum 5 (JP-5) jet fuel and one 300-gallon UST containing waste JP-5 (Figure 2-1). The 20,000-gallon USTs were made of fiber glass and were installed in 1976 and became operational in 1983. The 300-gallon UST was made of iron and was installed in 1984.

2.2 SITE HISTORY. As part of the Navy Release Detection program, four compliance monitoring wells were installed around the 20,000-gallon USTs in 1989. During the installation of the monitoring wells, petroleum-contaminated soil was detected.

ABB-ES initiated a contamination assessment at the site in September 1992. As part of the contamination assessment (CA), 10 soil borings and three monitoring wells were installed. ABB-ES sampled all site monitoring wells in October 1992. Detected concentrations of benzene and total naphthalenes in several groundwater samples slightly exceeded the State target levels. After reviewing the analytical data with the FDEP, a decision was made to resample all monitoring wells at the site. The wells were resampled in March 1993. Contaminant concentrations in one of the monitoring wells sampled suggested that a recent release or leak had occurred; therefore, ABB-ES recommended that the CSS Activity conduct a tightness testing on the 20,000-gallon USTs and associated pipelines. Activity personnel discovered 1.25 feet of free product in the same monitoring well in July 1993. Several tightness tests were conducted from May through July 1993, and a leak was discovered in the underground pipelines associated with UST #2, the middle UST. In August 1993, approximately 9 inches of free product was reported in a different monitoring well (MW-4). A technical memorandum presenting the findings of the CA up to March 1994 is attached in Appendix A.

ABB-ES mobilized to the site in July 1994 to install free-product recovery wells. Fourteen soil borings were advanced at the site to locate the area of greatest free-product thickness. One recovery well was installed on the north side of the tank pad, and two recovery wells were installed along the east side of the tank pad. After the installation of the recovery wells, only one well contained measurable free product (0.01 foot).

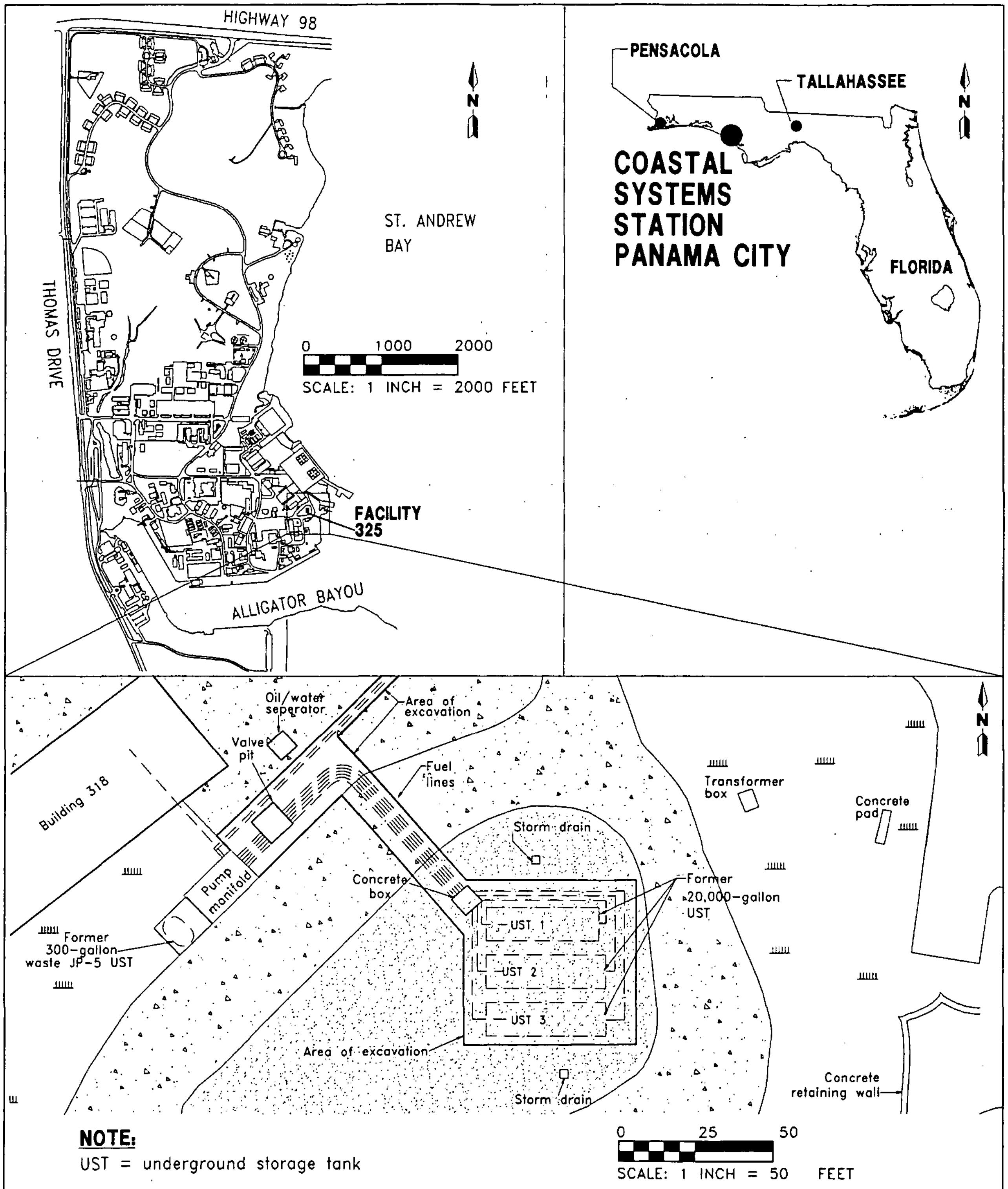

FIGURE 2-1
SITE LOCATION MAP

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SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

The Activity spent the next several months conducting a cost and benefit analysis comparing several possible courses of action at the site. The two main options evaluated were (1) removing the USTs and associated pipelines or (2) locating and repairing the fuel leak. The Activity made a decision to remove the USTs and pipelines and install a new system as part of an initial remedial action (IRA). SOUTHNAVFACENGCOM decided to use the remedial action contract contractor, Bechtel Environmental, Inc. (BEI), to remove the USTs and free product from the site and requested that ABB-ES provide oversight of BEI during free-product removal. ABB-ES's responsibilities were later revised to include UST, pipeline, and soil removal oversight.

ABB-ES, BEI, and BEI's subcontractor, Florida Petroleum Services, mobilized to the site to perform the IRA. The USTs and associated pipelines were removed in July and August 1995. During the excavation, 83 soil samples were collected from the backhoe bucket and screened with an organic vapor analyzer (OVA). Excessively contaminated soil (>50 parts per million [ppm] total headspace reading of OVA) in the area of the USTs and along the pipelines was removed and replaced with clean fill material (Figure 2-2). In total, approximately 490 cubic yards of excessively contaminated soil were removed from the site. Not all excessively contaminated soil was removed from the site; only the amount required to remove the tanks and pipes. The IRA scope of work also called for the removal of free product; however, only a slight sheen of free product was observed in the excavation. An attempt was made to remove the free product by vacuuming the groundwater surface for approximately 3 hours. The amount of free product removed was not measurable. A summary report of IRA activities is included in Appendix B.

Following removal of the USTs, ABB-ES returned to the site to complete the CA. Twenty-three soil borings were advanced, and 18 monitoring wells were installed to assess the horizontal and vertical extent of soil and groundwater contamination.

2.3 SUMMARY OF CONTAMINATION ASSESSMENT REPORT. Based on the findings of the CA field investigations and laboratory analytical results, the following is a summary of existing conditions at the site:

- The primary water-bearing zone of concern at the site is the surficial aquifer. The surficial aquifer in the Panama City area is unconfined and classified as a G-II groundwater source.

- The surficial aquifer was penetrated to a depth of 30 feet below land surface (bls) during the CA. Subsurface material is generally composed of fine- to medium-grained quartz sand, light brown to gray, well-sorted, with small amounts of clay (10 percent).

- The water table at the site was encountered at depths ranging from 5 to 7 feet bls.

- The direction of groundwater flow in the surficial aquifer is to the east. Figure 2-3 presents the water table elevation contours for water level measurements obtained on October 16, 1995.

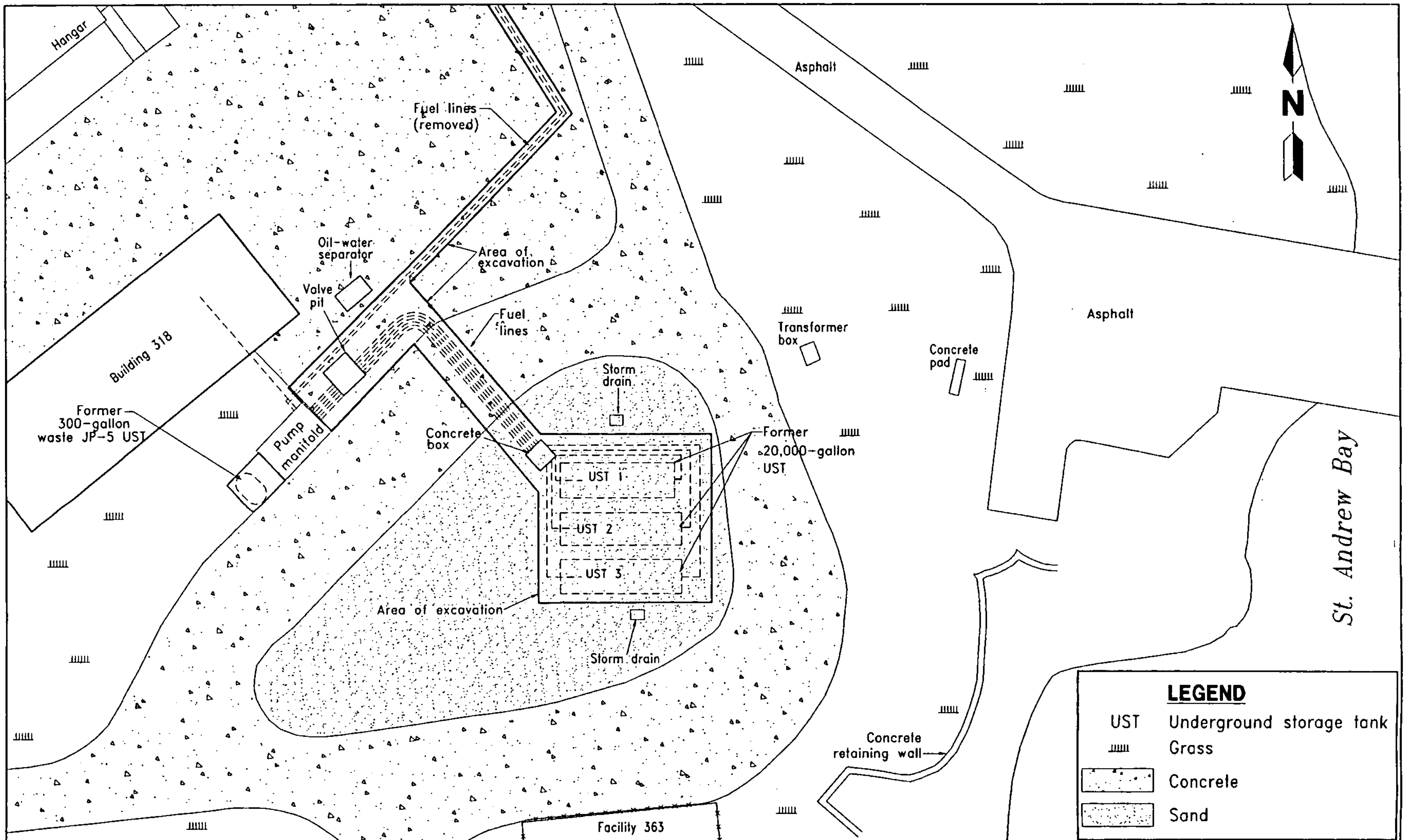

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FIGURE 2-2
SITE PLAN AND FORMER LOCATION OF USTs

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

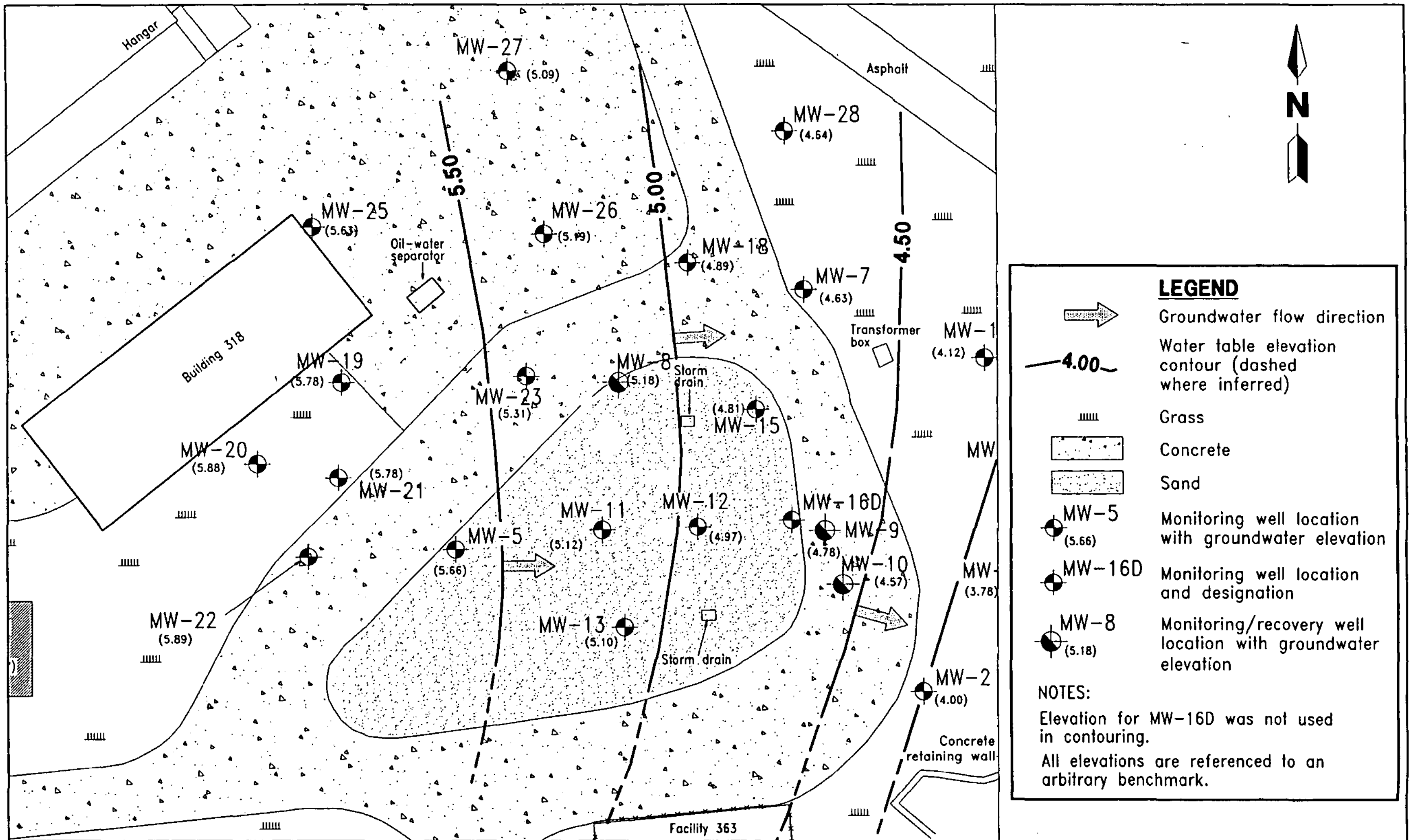

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FIGURE 2-3
GROUNDWATER POTENTIOMETRIC CONTOURS
OCTOBER 16, 1995

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

- Excessively contaminated soil(>50 ppm OVA headspace reading) was detected in the vicinity of the three former 20,000-gallon USTs, along the pipelines extending to the pump station and helipad and in the vicinity of the former 300-gallon waste JP-5 UST on the southwest side of the pump manifold. Much of the excessively contaminated soil is covered by asphalt or concrete.

- Total volatile organic aromatics (VOA) (sum of benzene, ethylbenzene, toluene, and xylenes), methyl tert-butyl ether (MTBE), polynuclear aromatic hydrocarbons (PAH), total recoverable petroleum hydrocarbons (TRPH), lead, and several chlorinated compounds were detected in groundwater samples. Total VOA, total PAH (excluding naphthalenes), total naphthalenes, TRPH, MTBE, and lead concentrations were compared to Chapter 62-770, FAC, target levels for Class G-II groundwater. Because Class G-II groundwater target levels are not available for chlorinated compounds, these contaminants were compared to State groundwater guidance concentrations (FDEP, June 1994). Only PAH (excluding naphthalenes) in six of the perimeter monitoring wells exceeded the Chapter 62-770, FAC, target levels for a monitoring only plan.

- Free product was encountered only in monitoring well MW-26 and measured 0.90 foot in thickness.

- The apparent sources of contamination—three 20,000-gallon USTs, one 300-gallon UST, and all associated pipelines—have been removed from the site.

- No potable water sources were identified within a 0.25-mile radius of the site. There appears to be no risk of contamination of the CSS Panama City public water supply system from activities at the site.

2.4 CONCLUSIONS. Based on the findings of the CA and site conditions, the following can be concluded:

- Groundwater contamination at the site appears to be related to releases from the former USTs and associated pipelines. These sources have been removed; therefore, groundwater contaminant concentrations can be expected to decrease over time by natural attenuation.

- Free product at the site is likely associated with one or more previous releases from the UST system. Very little of the free product released at the site was recovered during the UST system removal and subsequent IRA. The free product observed in monitoring well MW-26 on December 22, 1996, is probably part of an isolated pocket in the vadose zone that periodically migrates with water table fluctuations. A monitoring well inspection conducted on April 27, 1996, reported presence of free product in monitoring wells MW-8, MW-9, MW-15, MW-23, and MW-26.

- Excessively contaminated soil at the site will require remediation to meet clean soil standards as outlined in Chapter 62-770, FAC.

2.5 RECOMMENDATIONS. Because contamination in the groundwater and soil at Facility 325 exceeds the State's target levels for Class G-II groundwater and soil contaminated by kerosene group constituents (Chapter 62-770, FAC), it was recommended in the CAR that an RAP be prepared as a follow-up report to address cleanup of the contamination.

3.0 REMEDIAL ALTERNATIVES

3.1 CONTAMINANTS OF CONCERN. Contamination at the site is the result of the spill of JP-5 jet fuel. Therefore, the Chapter 62-770, FAC, kerosene analytical group of contaminants is the basis for the remedial design. These parameters are

- VOAs (U.S. Environmental Protection Agency [USEPA] Methods 601 and 602, including methyl tert-butyl ether);
- PAH (USEPA Method 610);
- TRPH (USEPA Method 418.1);
- ethylene dibromide (USEPA Method 504.1); and
- dissolved lead (USEPA Method 239.2).

3.2 APPLICABLE CLEANUP STANDARDS. Standards and regulations regarding required remedial goals for soil and groundwater are contained in Chapter 62-770, FAC, and should be applied following treatment by any method. The table below presents the remedial goals for soil and groundwater at Facility 325.

Parameter	Target Concentration	
	Soil	Groundwater
OVA reading for excessively contaminated soil	50 ppm	
Total Volatile Organic Aromatics (VOA)		50 μg/ℓ
Benzene		1 μg/ℓ
1,2-Dibromomethane (EDB)		0.02 μg/ℓ
PAHs excluding Naphthalenes		10 μg/ℓ
Total Naphthalenes		100 μg/ℓ
Lead		50 μg/ℓ
Methyl Tert-Butyl Ether (MTBE)		50 μg/ℓ
Total Recoverable Petroleum Hydrocarbons		5 mg/ℓ

Notes: OVA = organic vapor analyzer.
ppm = parts per million.
μg/ℓ = micrograms per liter.
mg/ℓ = milligrams per liter.

3.3 EXTENT OF CONTAMINATION. Areas of contamination at CSS Panama City, Facility 325 include the free product consisting of degraded JP-5 jet fuel, soil contaminated with kerosene analytical group petroleum hydrocarbons, and groundwater contaminated with total VOA, PAHs including total naphthalenes and TRPH. The paragraphs below present a description on the extent of contamination in each of the areas.

3.3.1 Free-Product Assessment Free product was encountered only in monitoring well MW-26 and measured 0.90 foot in thickness on December 22, 1995. This was the first time measurable free product had been observed in any site monitoring or recovery well. The depth to groundwater in MW-26 on December 22, 1995, was 7.42 feet bls, indicating a lower water table elevation than last measured on October 16, 1995. Free product may have accumulated in MW-26 as the water table fluctuated through petroleum-saturated soil. No source of petroleum other than the former JP-5 pipelines was identified in the vicinity of monitoring well MW-26. The free product was removed from MW-26 by a vacuum truck on December 22, 1995. Approximately 146 gallons of groundwater and 17 gallons of free product were removed. After vacuuming for 90 minutes, less than 0.01 foot of free product remained in MW-26. The free product was emptied into the oil-water separator on the northwest side of the site. A monitoring well inspection conducted on April 27, 1996, reported presence of free product in monitoring wells MW-8, MW-9, MW-15, MW-23, and MW-26. Figure 3-1 presents the distribution of free product based on the thickness measurements made on April 27, 1996. Estimated volume of free product, based on calculations included in Appendix A, is about 500 gallons.

3.3.2 Soil Contamination Assessment A summary of the soil sample OVA analyses is presented in Table 3-1. (Note: Confirmatory soil samples collected during the IRA are not included in Table 3-1.) Soil containing constituents of the kerosene analytical group with OVA headspace readings exceeding 50 ppm are defined as "excessively contaminated" and must be remediated, except under extenuating circumstances.

Excessively contaminated soil was detected in the vicinity of the three former 20,000-gallon USTs, along the pipelines extending to the pump and helipad, and in the vicinity of the former 300-gallon waste JP-5 UST on the southwest side of the pump manifold (Figure 2-2). The total area of excessively contaminated soil is outlined by the 50 ppm isoconcentration line and is included on Figure 3-1 (Note: OVA readings of IRA confirmatory soil samples collected above and below the 300-gallon waste JP-5 UST were greater than 50 ppm. Therefore, this area is included within the 50 ppm isoconcentration line). OVA readings in all borings increased with depth. In most of the borings, the highest OVA reading occurred immediately above the water table. Much of the excessively contaminated soil is covered by asphalt or concrete.

3.3.3 Groundwater Contamination Assessment Analytical laboratory results for the groundwater samples collected October 14, 1992, March 8, 1993, and October 17 through October 19, 1995, are attached in Appendix A and summarized in Table 3-2. VOA, MTBE, PAH (including naphthalenes), TRPH, lead, and several chlorinated compounds were detected in groundwater samples. For petroleum compounds regulated under Chapter 62-770, FAC, Class G-II groundwater target levels are used, where applicable. Florida no further action or monitoring only target levels for G-II groundwater and for no potable wells within 0.25 mile of the site have been established for benzene (50 parts per billion [ppb]), total VOA (50 ppb), MTBE (50 ppm), total naphthalenes (100 ppb), TRPH (5 ppm), and lead (50 ppb) (Florida Department of Environmental Regulation [FDER], October 1990). Total VOA isoconcentration contour for groundwater is included on Figure 3-2. Total naphthalene isoconcentration contours are presented on Figure 3-3. TRPH isoconcentration contours are presented in Figure 3-4. Chlorinated compounds are compared to Chapter 62-770, FAC, recommended guidance concentrations of 700 ppb for 1,1-dichloroethane and 75 ppb for 1,4-dichlorobenzene (FDEP, June 1994). Petroleum contaminant concentrations exceeding State regulatory levels are presented in Table 3-2.

CSSPC325.RAP
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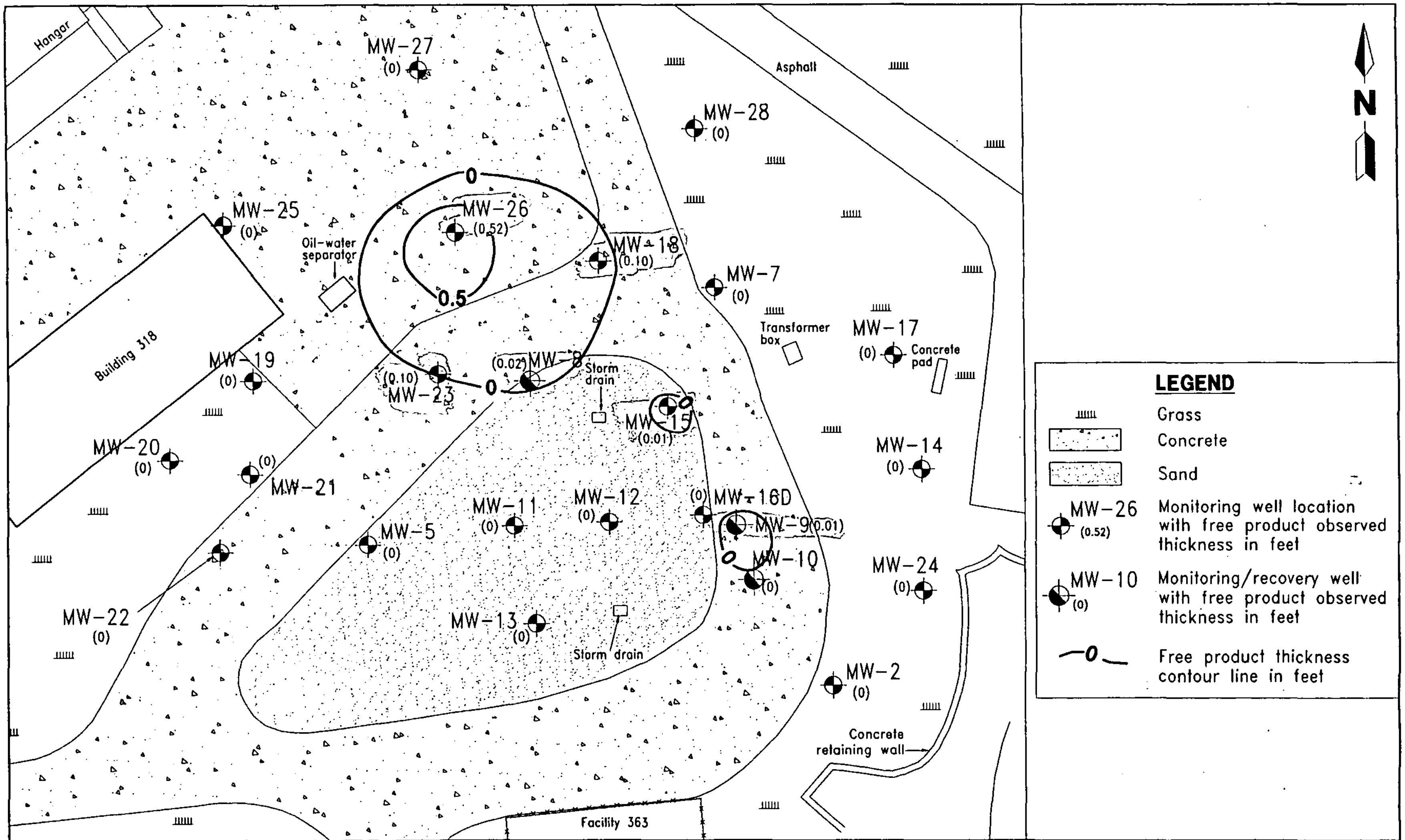

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FIGURE 3-1
FREE PRODUCT DISTRIBUTION MAP
APRIL 27, 1996

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

Table 3-1
Soil Sample Organic Vapor Analyzer (OVA) Analyses,
July 28, 1994, through September 30, 1995

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Boring Designation	Sample Depth (feet bls)	OVA Headspace Concentration (ppm)	Comments
SB1	3 to 5	165	Petroleum odor.
	5 to 7	4,200	Petroleum odor, wet.
SB2	3 to 5	200	Petroleum odor.
	5 to 7	3,100	Petroleum odor, wet.
SB3	3 to 5	1,700	Petroleum odor.
	5 to 7	3,400	Petroleum odor, wet.
SB4	3 to 5	0	No odor.
	5 to 7	110	Slight odor, wet.
SB5	3 to 5	70	Petroleum odor.
	5 to 7	100	Petroleum odor.
SB6	0 to 2	0	Slight odor.
	2 to 4	120	Petroleum odor.
SB7	3 to 5	0	No odor.
	5 to 7	2,400	Strong petroleum odor.
SB8	3 to 5	0	No odor
	5 to 7	900	Petroleum odor
SB9	3 to 5	1,700	Strong petroleum odor.
	5 to 7	NS	Refusal at 5 feet.
SB10	3 to 5	2	No odor.
	5 to 7	3	No odor, wet.
SB11	3 to 5	1,200	Strong petroleum odor.
	5 to 7	>5,000	Strong petroleum odor, wet.
SB12	3	0	No odor.
	4	0	Met refusal.
SB13	3 to 5	850	Strong petroleum odor. Refusal at 5 feet.
SB14	3 to 5	NM	No odor.
SB15	0 to 2	0	No odor.
	2 to 4	1,300	Petroleum odor.
	4 to 6	2,700	Strong petroleum odor, wet.
SB16	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	0	No odor,wet.
SB17	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	0	No odor, wet.
SB18	0 to 2	0	No odor.
	2 to 4	6	No odor.
	4 to 6	0	No odor.
	6 to 8	1,000	No odor, wet.

See notes at end of table.

Table 3-1 (Continued)
Soil Sample Organic Vapor Analyzer (OVA) Analyses, July 28, 1994, through September 30, 1995

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Boring Designation	Sample Depth (feet bls)	OVA Headspace Concentration (ppm)	Comments
SB19	0 to 2	0	No odor.
	2 to 4	0	no odor.
	4 to 6	3,500	Petroleum odor, wet.
SB20	0 to 2	898	No odor.
	2 to 4	260	No odor.
	4 to 6	>5,000	Strong petroleum odor.
	6 to 8	2,700	Strong petroleum odor, wet.
SB21	0 to 2	<1	No odor.
	2 to 4	<1	No odor.
	4 to 6	85	Petroleum odor.
	6 to 8	1,800	Petroleum odor, wet
SB22	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	0	No odor.
	6 to 8	35	Slight odor, wet.
SB23	0 to 2	1,000	Slight petroleum odor.
	2 to 4	1,200	Petroleum odor.
	4 to 6	3,400	Petroleum odor.
	6 to 8	3,300	Petroleum odor, wet.
SB24	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	0	No odor.
	6 to 8	6	No odor, wet.
SB25	0 to 2	0	No odor.
	2 to 4	270	Slight petroleum odor.
	4 to 6	2,500	Petroleum odor.
	6 to 8	2,900	Strong petroleum odor, wet.
SB26	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	5	No odor, wet.
SB27	0 to 2	400	No odor.
	2 to 4	1,300	No odor.
	4 to 6	4,200	Petroleum odor, wet.
	6 to 8	4,400	Petroleum odor, wet.
SB28	0 to 2	0	No odor.
	2 to 4	70	No odor.
	4 to 6	2,500	Strong petroleum odor, wet.
SB29	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	0	No odor, wet.
SB30	0 to 2	350	Slight petroleum odor.
	2 to 4	3,000	Strong petroleum odor.
	4 to 6	4,000	Strong petroleum odor, wet.

See notes at end of table.

Table 3-1 (Continued)
Soil Sample Organic Vapor Analyzer (OVA) Analyses, July 28, 1994, through September 30, 1995

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Boring Designation	Sample Depth (feet bls)	OVA Headspace Concentration (ppm)	Comments
SB31	0 to 2	240	Slight petroleum odor.
	2 to 4	2,100	Strong petroleum odor.
	4 to 6	4,500	Strong petroleum odor, wet.
SB32	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	0	No odor.
	6 to 8	0	No odor, wet.
SB33	0 to 2	0	No odor.
	2 to 4	0	No odor
	4 to 6	1,900	Petroleum odor.
	6 to 8	2,200	Strong petroleum odor, wet.
SB34	0 to 2	0	No odor.
	2 to 4	11	No odor.
	4 to 6	0	No odor, wet.
SB35	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	5	No odor.
	6 to 8	0	No odor, wet
SB36	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	0	No odor.
	6 to 8	1,300	Petroleum odor, wet
SB37	0 to 2	0	No odor.
	2 to 4	0	No odor.
	4 to 6	60	Petroleum odor, wet.

Notes: bls = below land surface.
ppm = parts per million.
NS = not sampled.
> = greater than.
NM = not measured.
< = less than.

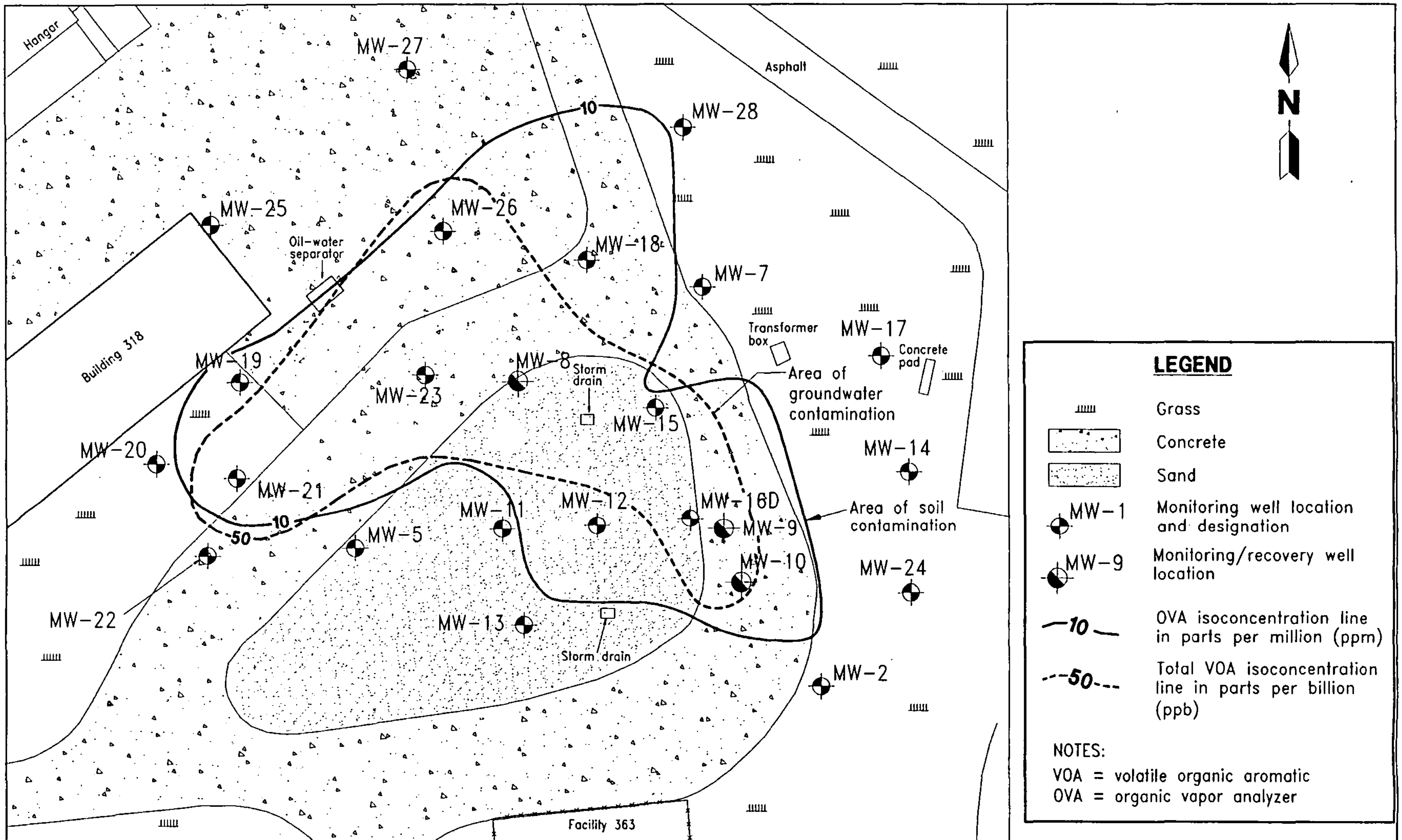
Table 3-2
Petroleum Contaminant Concentrations Exceeding State Regulatory Levels, for G-II Groundwater
October 1992 through October 1995

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Monitoring Well Designation	Year	Contaminant	Contaminant Concentration	Applied Standard[1]
MW-1	1992	Total naphthalenes	108	100
MW-2	1992	Total naphthalenes	123	100
MW-4	1993	Total VOA	228	50
		Total naphthalenes	133,000	100
		TRPH	15,000	5
MW-6	1993	Total VOA	70	50
		Total naphthalenes	185	100
MW-8	1995	Total VOA	141	50
		Total naphthalenes	750	100
MW-9	1995	Total VOA	51	50
		Total naphthalenes	221	100
		TRPH	6.1	5
MW-10	1995	Total VOA	52	50
		Total naphthalenes	164	100
MW-12	1995	TRPH	8.3	5
MW-15	1995	Total VOA	61	50
		Total naphthalenes	208	100
MW-21	1995	Total VOA	127	50
		Total naphthalenes	176	100
MW-23	1995	Total VOA	151	50
		Total naphthalenes	614	100
MW-26	1995	Total VOA	143	50
		Total naphthalenes	265	100
		TRPH	6.1	5

[1] State target level for Class G-II groundwater and no potable wells within 0.25 mile (FDEP, May 1994).

Notes: Concentrations are in parts per billion except TRPH, which is reported in parts per million.
Total VOA is the sum of benzene, toluene, ethylbenzene, and xylenes.
Total naphthalenes is the sum of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.
VOA = volatile organic aromatics.
TRPH = total recoverable petroleum hydrocarbons.
FDEP = Florida Department of Environmental Protection.



0 25 50
SCALE: 1 INCH = 50 FEET

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FIGURE 3-2
GROUNDWATER TOTAL VOA AND SOIL OVA CONCENTRATION DISTRIBUTION MAP

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

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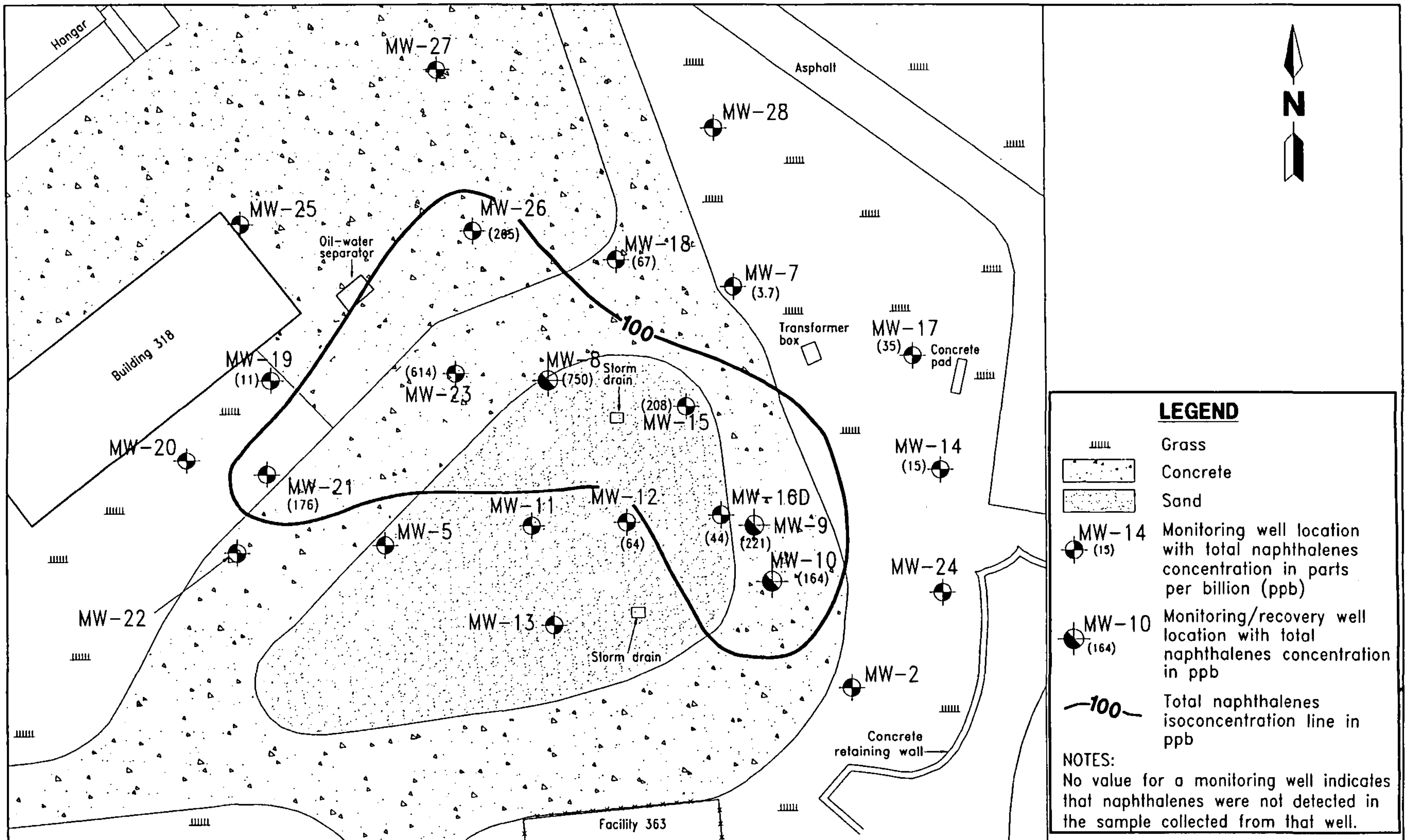

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SCALE: 1 INCH = 50 FEET

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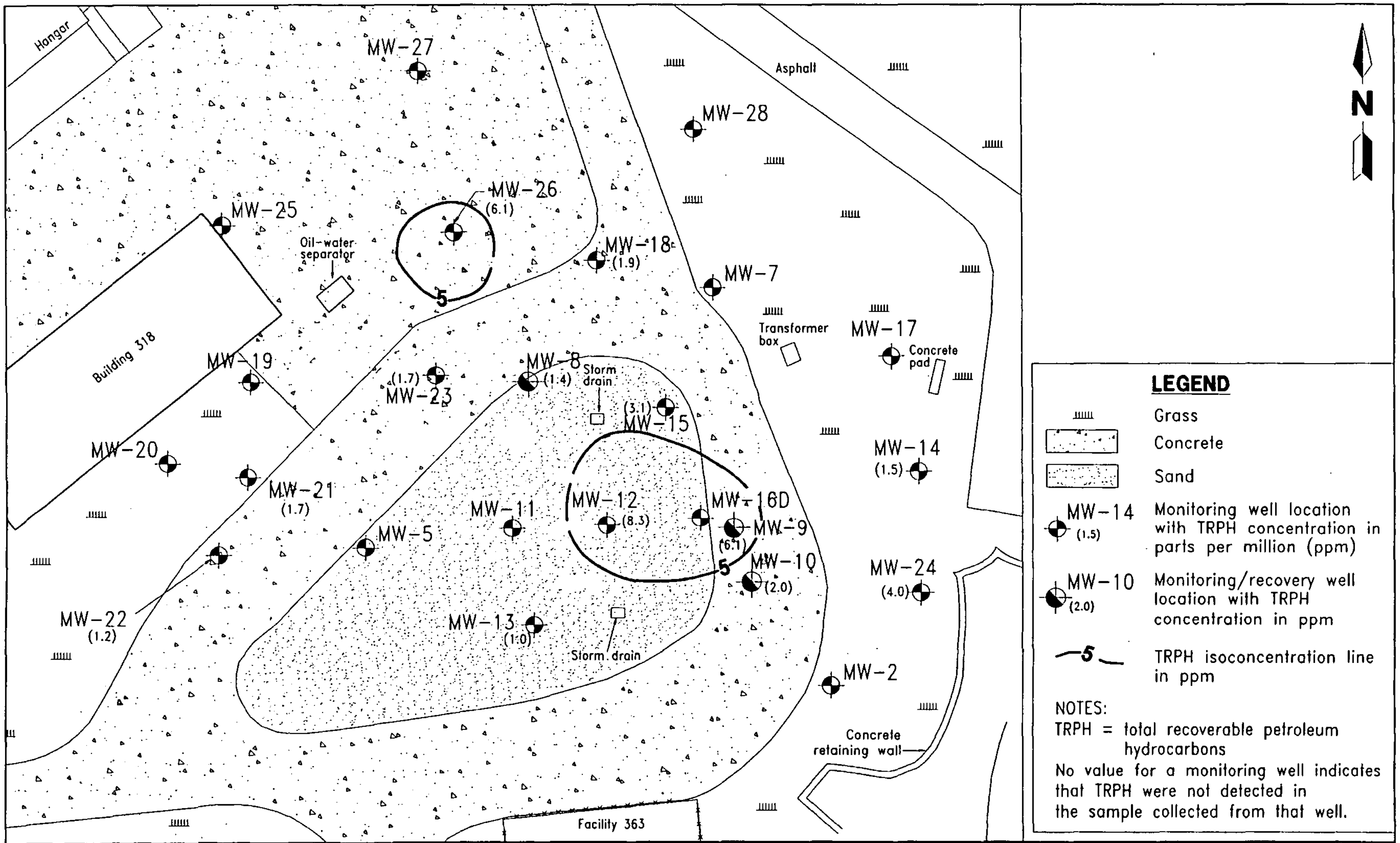
FIGURE 3-3
TOTAL NAPHTHALENES CONCENTRATIONS IN GROUNDWATER OCTOBER 1995

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA



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SCALE: 1 INCH = 50 FEET

FIGURE 3-4
TOTAL RECOVERABLE PETROLEUM HYDROCARBONS (TRPH) IN GROUNDWATER OCTOBER 1995

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

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3.4 EXPOSURE PATHWAYS. The potential exposure pathways for the existing contaminants in groundwater are either via direct ingestion through an existing potable water supply well within the zone of contamination, or migration of contaminated water into St. Andrew Bay, which is class III surface water. These two pathways have very limited probability of existence due to the following reasons:

- There are no active potable wells within the zone (0.25 mile radius) of contamination. CSS Panama City's supply of potable water is obtained from the Panama City Municipal Water Supply. A potable well survey was conducted to show the proximity of potable water sources to contamination associated with activities at Facility 325. There are four former public water supply wells located at CSS Panama City (PWS-1, PWS-2, PWS-3, and PWS-4). Figure 3-5 shows the locations of these wells. Three of the wells, PWS-2, PWS-3, and PWS-4, are located within a 0.25-mile radius of the site. Only PWS-1 is currently in use. Well PWS-1 is used for heating and air conditioning purposes only and draws water from approximately 400 feet bls. The remaining production wells (PWS 2, PWS 3, and PWS 4) are inactive. The four public water supply wells are screened in the Floridan aquifer system at depths ranging from 350 to 400 feet bls. Well inventory data are presented in Table 3-3.

- Direct migration of contaminants to the adjacent St Andrew Bay is not established at this time. St. Andrew Bay is about 200-250 feet southeast of the location of perimeter wells at Facility 325. None of the perimeter wells have had any contaminants detected.

3.5 SITE-SPECIFIC LIMITATIONS TO ALTERNATIVES. Facility 325 is presently inactive; however, construction activities related to the truck stand and installation of underground fuel supply lines are anticipated to occur in the middle of the Fiscal Year 1997. A substantial portion of the soil contamination is located beneath a concrete pavement that serves as a roadway (see Figure 3-2). Problems due to excessive traffic or military activity do not exist at this time. Remedial construction or operation and maintenance activities would be acceptable in the area defined; however, subsurface features that may be in place before the system installation may restrict construction activities to some extent. Figure 3-6 presents the plan view of the proposed construction details.

3.6 REMEDIAL STRATEGY. A remedial system chosen for Facility 325 should be designed to address the area of free product and the associated soil and groundwater contamination. Characteristics of the remedial system are as follows:

- Contamination associated with the free product is reported as confined to small pockets and would be dealt with through a monitoring and recovery program.

- Contamination associated with the soil is confined between 2 ft bls to 6 ft bls (location of the water table) and has an estimated volume of 3,000 cubic yards. Technologies selected for soil

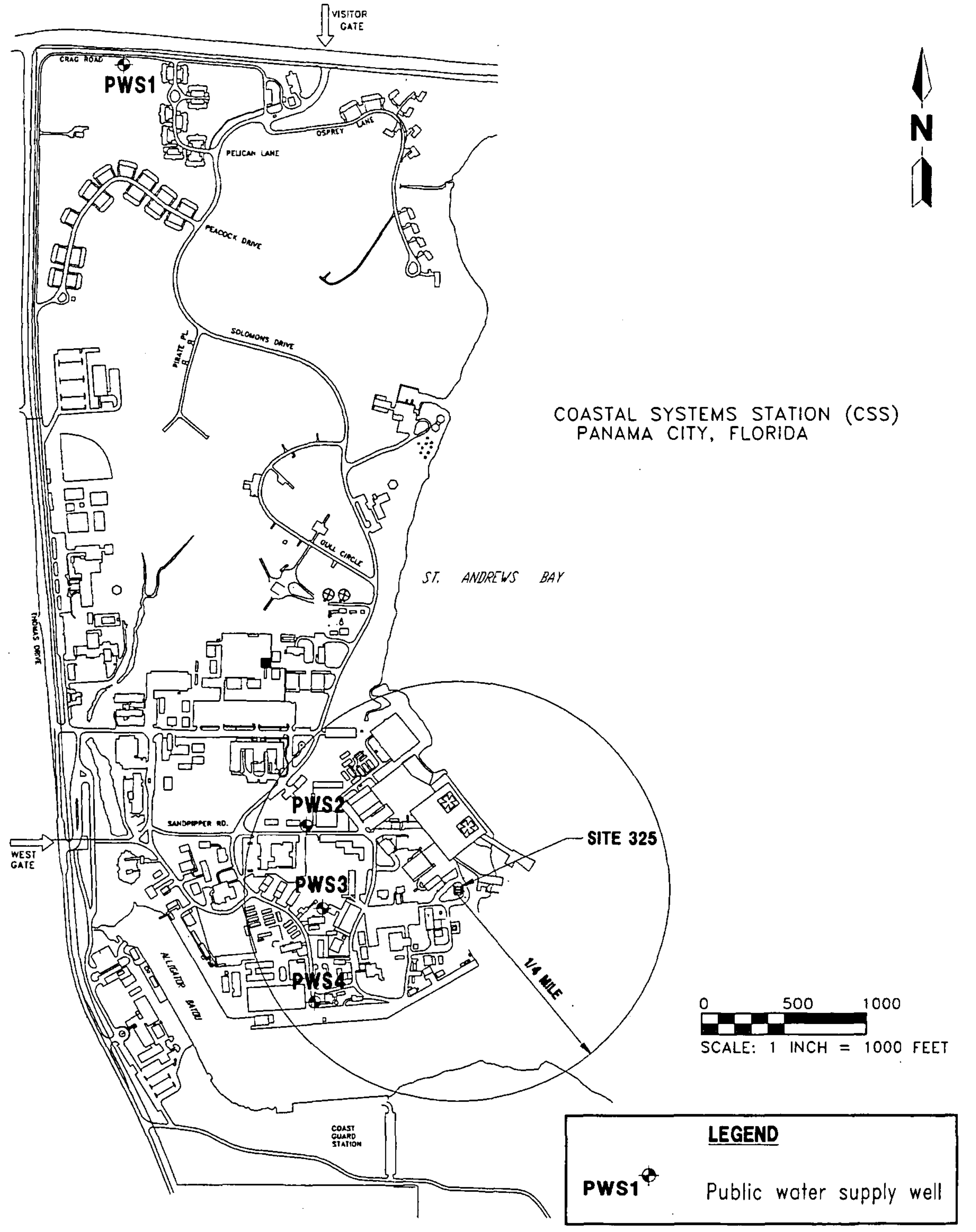

FIGURE 3-5
LOCATION OF PUBLIC SUPPLY WELLS, COASTAL SYSTEMS STATION PANAMA CITY

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REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

Table 3-3
Public Water Supply Wells Data

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Well Identification Number/Local Number	Location	Total Depth (feet bls)	Casing Diameter (inches)
Building 394, PWS 1	Building 394	400	12
Building 281, PWS 2	Building 281	350	12
Building 10, PWS 3	Building 10	350	12
Building 101, PWS 4	Building 101	350	12

Note: bls = below land surface.

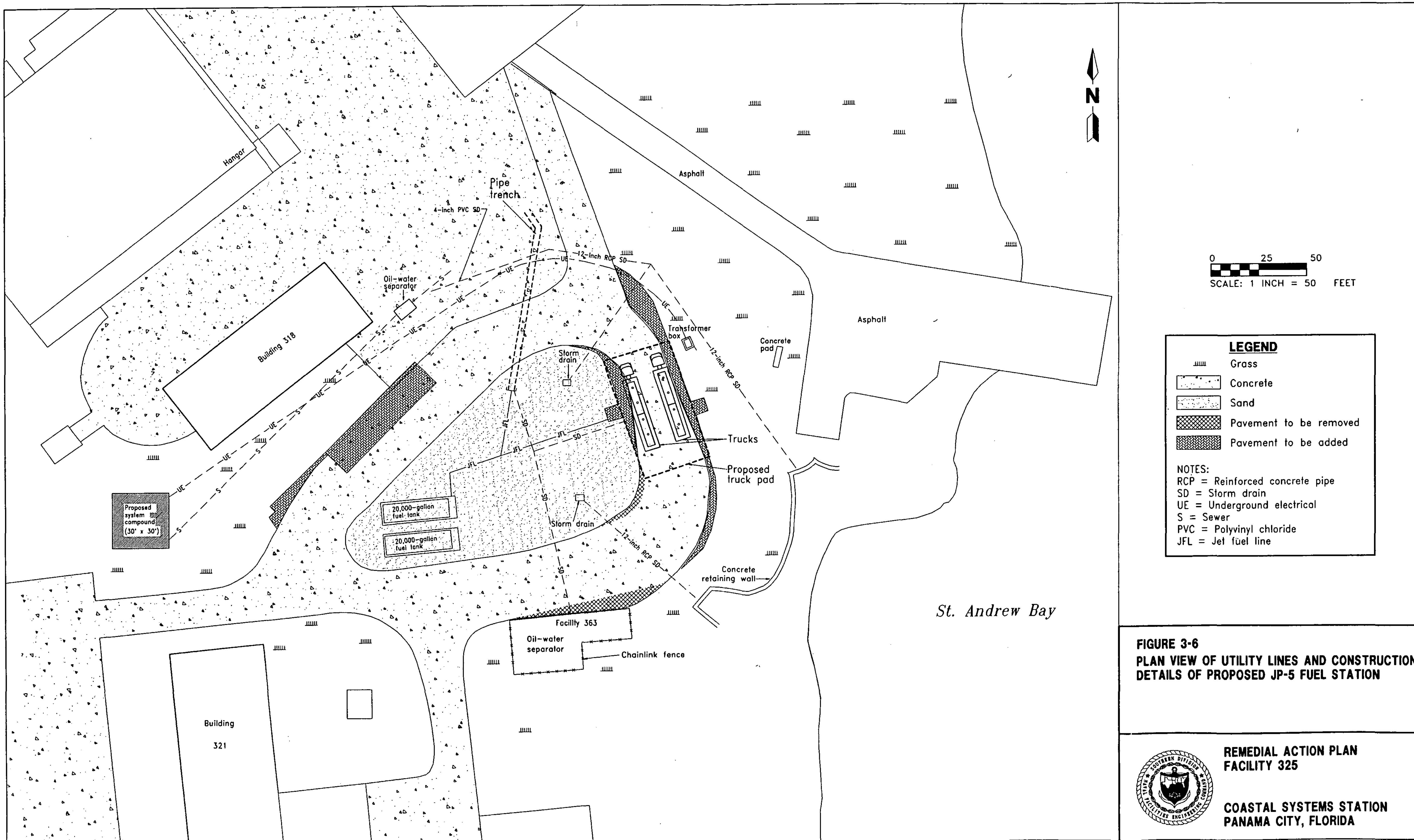

FIGURE 3-6
PLAN VIEW OF UTILITY LINES AND CONSTRUCTION DETAILS OF PROPOSED JP-5 FUEL STATION

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

treatment should allow simultaneous implementation of free-product monitoring and recovery program.

- Contaminants associated with groundwater are confined within a water column of 19 feet thickness below the groundwater table (i.e., between 6 ft bls and 25 ft bls). Chemicals of concern, including total VOA, total naphthalenes and TRPH, are anticipated to be naturally attenuated.

- Effectiveness of any groundwater treatment technologies will be significantly dependent on potential continued existence of free product in the saturated zone. Hence, additional groundwater treatment, if required, will be proposed, but initiated after the free product is completely removed from the aquifer.

3.7 DISCUSSION OF ALTERNATIVES. After defining the contaminants of concern, the applicable cleanup standards, extent of contamination, and exposure pathways, and developing a remedial strategy, it is necessary to identify and screen technologies that may be applicable to mitigating the contamination at the site. Because each site is unique and cleanup technologies applicable to sites contaminated with petroleum substances are continually being improved and developed, it is important to develop remedial action alternatives using the most effective technologies available.

3.7.1 Free-Product Removal The CAR has identified that the free product was found for the first time at MW-26 on December 22, 1995. A free-product survey conducted on April 27, 1996, has reported continued existence of free product at MW-26, with a thickness of 0.52 foot. A free-product removal system may include either a passive, active, or a combination of passive and active means of removal, based on the amount of recoverable free product in the unsaturated and saturated zones of the aquifer.

Passive mode of Free-Product Removal Passive mode involves technologies that rely on the existing hydraulic gradients of the free product and groundwater. Two technologies are considered for evaluation: (1) Free-product removal by periodic manual bailing and (2) the use of commercially available oil-absorbing hydrophobic socks inside the monitoring well with periodic extraction of free product from the socks. Efficiency of these technologies is dependent on the natural gradient of free product near the well and availability of recoverable free product within the zone of the screen interval of the monitoring well.

Active Mode of Free-Product Removal Active mode involves technologies that would actively enhance the fluid recovery process by inducing low pressures within the extraction well at the oil-water interface and accelerate accumulation of free product within the extraction well during recovery. Two technologies are considered for the active mode of free product removal. The technologies evaluated include use of submersible skimmer pumps and the use of vacuum enhanced extraction.

Submersible Skimmer Pumps. Submersible pumps create pressure differences by lowering the free-product levels within the extraction well. However, skimmer pumps cannot enhance the natural hydraulic gradient of free product. Hence, efficiency of a skimmer pump is greatly dependent on the potential for continued migration of recoverable free product into the extraction well.

Vacuum Enhanced Extraction (VEE). VEE involves removal of free product, soil vapor, and groundwater by applying a high vacuum (6 to 12 inches of mercury [Hg]) to the recovery well. An application of high vacuum to the well-head increases the hydraulic gradient of free product and groundwater. When the vacuum is applied in the well, liquids in the well and pore gasses in the soil will migrate towards the extraction well due to reduced pressure above the fluid interfaces.

3.7.2 **Soil Remediation** Soil remediation may be accomplished via two approaches: These are *ex situ* and *in situ* alternatives; both approaches are described below.

Ex situ Treatment *Ex situ* treatment alternatives involve soil excavation followed by a selected treatment alternative. Five types of *ex situ* treatment technologies that are applicable to this site are onsite incineration, thermal desorption, thermal aeration, offsite incineration, and offsite landfilling. Each of these technologies is briefly described in Table 3-4.

> *Ex situ* treatment technologies are best applicable in situations where the site is free of any existing structures, facilities, underground utilities, and the volume to be treated is relatively low. Even though Facility 325 soils have a volume of 3,000 cubic yards, the use of *ex situ* technologies will not be feasible due to existing structural features, and the proposed installation of a new JP-5 fuel system.

In situ Treatment Two types of *in situ* treatments that may be suitable to this site are soil vapor extraction (SVE) and biological degradation or intrinsic biodegradation.

SVE systems may be used to remediate soil in the vadose zone or dewatered saturated zones. This technology generally consists of vacuuming gases from unsaturated soil through SVE wells with vacuum pumps. Negative pressure induced by the vacuum draws gases through the soil pore spaces. Air inlet wells combined with a surface cover may be used to facilitate the flow of atmospheric air into the soil to replace the extracted gases. Soil permeability and contaminant volatility are critical factors in the success of these systems. The extracted gases can be treated as necessary before discharge to the atmosphere. Implementation of an SVE system at Facility 325 is feasible because of the following factors:

- Facility 325 has fine-to very fine-grained sand in the vadose zone. Intrinsic permeability is anticipated to range from 10^{-8} to 10^{-6} square centimeters (cm^2). Intrinsic permeability estimates based on the hydraulic conductivity reported in the CAR ranges from 10^{-8} to 10^{-7} cm^2.

- Contaminants of concern are constituents of JP-5 that are classified as kerosene analytical group constituents of petroleum hydrocarbons, and a substantial portion of the constituents are relatively volatile and amenable to SVE (vapor pressure range: 10 - 200 Hg at 20 degrees celsius (^{0}C); boiling point range: 180 - 300 ^{0}C; and Henry's Law Constant range: 20 - 300 atmospheres.

Table 3-4
Ex Situ Soil Treatment Technologies

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

General Response Action	Soil Technology	Description
Soil removal and disposal	Offsite landfill	Soil or sediment not regulated by RCRA land disposal restrictions is excavated and hauled to a secure, existing landfill.
Soil removal and treatment	Onsite incineration	Soil or sediment is excavated and treated by a mobile incinerator that thermally destroys organics in a direct-fired treatment unit.
	Thermal aeration	Soil or sediment is excavated and treated by a mobile unit that volatilizes organic contaminants from soil or sediment and destroys them in a secondary combustion chamber.
	Thermal desorption	Soil or sediment is excavated and treated by a mobile unit that volatilizes organic contaminants from soil or sediment and condenses them into a liquid stream.
	Offsite incineration	Soil or sediment is excavated and hauled to a licensed incinerator that thermally destroys organics in a direct-fired treatment unit.

Note: RCRA = Resource Conservation and Recovery Act

Intrinsic biodegradation or biological degradation can be accomplished if sufficient oxygen and moisture levels occur below land surface. The greatest amount of microbial activity was reported to occur for soil oxygen content greater than (>) 2 percent and groundwater dissolved oxygen > 2 milligrams per liter. Maintaining proper levels of oxygen requires that the soil is relatively permeable (with an intrinsic permeability greater than or equal to 10^{-8} cm^2). Also, the moisture available for the transport of microorganisms should be in the range of 40 to 85 percent of field capacity for the biodegradation to be sustained (USEPA, 1995). If petroleum-degrading bacteria microorganisms are present (microbes capable of degrading petroleum products are present in almost all subsurface environments) in the vadose zone and proper conditions are met, aerobic or anaerobic degradation of the contaminant can occur. Oxygen levels in the vadose zone are sometimes controlled to maximize the degrading capacity of the microorganisms.

3.7.3 Groundwater Remediation As described in Section 3.4, groundwater at Facility 325 does not present any threat to human health or environment. Concentrations of total VOA, TRPH and PAHs are anticipated to naturally attenuate over time. However, cost effective means to accelerate the cleanup of groundwater are evaluated in conjunction with natural attenuation. Groundwater remediation may be accomplished via *ex situ* treatment or *in situ* treatment.

***Ex situ* Treatment** This alternative would consist of collecting the contaminated groundwater, treating it to reduce contaminant mobility, toxicity, and volume, and disposing of the treated effluent. The groundwater would be collected through extraction wells. Treatment technologies considered include options that use CSS Panama City's oily-waste collection and treatment system, and those that require installing alternate treatment systems onsite.

Groundwater Extraction If *ex situ* treatment of groundwater is selected, a groundwater extraction method must be proposed. Alternatives considered include extraction wells, vacuum enhanced extraction systems, and recovery trenches.

Extraction wells consist of one or more wells from which groundwater can be pumped to the treatment system. Wells are designed based on the location of the contamination, the aquifer hydraulic conductivity, the hydraulic gradient of the water table, and the depth to the water table. The depth, diameter, screen length, pumping rate and draw down for each well, as well as the number and location of wells are designed to produce the appropriate capture zone. This is a widely used and accepted groundwater recovery method.

Combined vapor-fluid vacuum enhanced extraction systems consist of vacuum pumps that remove soil vapors and dewater the selected zone simultaneously. The systems typically are similar to well point dewatering systems with draw tubes within the vapor recovery well. If a saturated part of the aquifer is dewatered, air continues to flow through the pores allowing the remediation to continue. This is particularly an advantage in aquifers with low transmissivities. Because the depth of dewatering is controlled by the magnitude of the vacuum, the affected area is automatically maintained during variation of the water table. This method has a physical limitation on the depth from which water can be removed. Theoretically, a perfect vacuum can support a water column of about 34 feet. In application this method can typically lift water from 18 to 20 feet below the elevation of the vacuum pump. This option would not incur any additional cost, if combined with the VEE option of free-product removal, and groundwater is extracted in batch flow rather than continuous extraction. Thus volumes of groundwater will be extracted along with the recovery of free product.

Recovery trenches typically consist of perforated pipe laid in a trench, which is backfilled with a material that is more permeable than the surrounding soil. Groundwater flows by gravity into the pipe and to a sump where it is collected and pumped to the treatment system. Recovery trenches can be placed at the water from all directions, or downgradient and perpendicular to the flow direction to intercept the flow at sites with greater water table gradients.

Groundwater Treatment Extracted groundwater may be treated at the oily-waste collection and treatment system located on base. This system consists of a collection tank, an oil-water separator, and a wastewater treatment plant.

Several other treatment trains involving the following technologies may also be considered for treatment of groundwater:

- Ultraviolet/oxidation
- Air stripping
- Granular activated carbon (GAC) adsorption
- Biological treatment

These technologies are capital intensive and require substantial operation and maintenance effort. Facility 325 does not warrant use of any of these technologies for groundwater because of the availability of the existing treatment system.

Effluent Disposal If *ex situ* treatment of groundwater is selected, disposal of the treated effluent must be considered. The options considered include discharge to the CSS Panama City oily-waste collection and treatment system, reinjection to the groundwater, and discharge to a surface water body.

The CSS Panama City oily-waste collection and treatment system has sufficient capacity to accept the treated effluent. There would be virtually no additional disposal costs associated with this option.

Installation of recharge galleries is not feasible at Facility 325. The existing structures at the site would make it difficult to excavate trenches and discharge treated effluent through a recharge gallery.

Discharge to a surface water body would be easy to implement, but would require a National Pollution Discharge Elimination System permit. The permit monitoring requirements, which might include more frequent sampling and bioassays, would add significantly to the cost of this option.

***In situ* Treatment** This alternative would consist of treating groundwater to reduce the mobility, toxicity, and/or volume of the contamination without removal. *In situ* treatment technologies being considered include natural attenuation, enhanced bioremediation, and aquifer air sparging.

Natural Attenuation Natural attenuation consists of destructive and non-destructive attenuation of contaminants in groundwater. Components of non-destructive attenuation include volatilization, dispersion, dilution, and adsorption. Components of destructive attenuation include aerobic and anaerobic biological degradation. Natural attenuation is appropriate if the following conditions are satisfied:

- Documented loss of contaminants of concern at the field scale.
- Evidence of biodegradation by means of geochemical indicators including nutrient concentrations such as oxygen, sulfur, phosphorous, and nitrogen.
- Evidence of laboratory microcosm studies for the specific contaminants of concern, and existence of petroleum-degrading microorganisms in groundwater.

Enhanced Bioremediation Enhanced bioremediation typically involves the delivery of nutrients to bacteria that degrade the petroleum products, breaking them down to carbon dioxide and water. Some type of initial testing is typically required to assess the existing level of biological activity and the appropriate nutrient supplements needed to affect the biodegradation. This technology has been used successfully to reduce VOC contamination levels. Implementation would require a system for injection of nutrients and oxygen. The biological processes may be difficult to control *in situ*, and nutrients would be difficult to deliver due to the pavement at the site.

Aquifer Air Sparging Aquifer air sparging (AAS) is an *in situ* remedial technology that reduces concentrations of volatile constituents in petroleum products that are adsorbed to soils and dissolved in groundwater. This technology, which is also known as "*in situ* air sparging" involves the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor phase. The air is then vented through the unsaturated zone. AAS is most often used together with SVE, but it can also be used with other remedial technologies. When air sparging is combined with SVE, the SVE system creates a negative pressure in the unsaturated zone through a series of extraction wells to control the vapor plume migration. This combined system is called AAS/SVE.

AAS is not effective if free-phase petroleum product is present at the site. Application of AAS results in potential mounding of groundwater around the sparge well, thus resulting in smearing of the free product in the unsaturated zone. The CA has reported presence of free product at Facility 325. Hence, implementation of AAS at Facility 325 will be evaluated at a time when all the recoverable free product is removed from the aquifer.

Table 3-5 presents a list of all the technologies evaluated for Facility 325 and describes the rationale for screening and selection of technologies for further consideration.

3.8 ALTERNATIVE SELECTION. The following presents the characteristics of the remedial system:

- The primary contaminants of concern are the free product and the associated soil contamination. Hence, the remedial system should be

Table 3-5
Selection of Technologies

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Component	Technology	Rationale	Decision
Free-Product Removal	Manual bailing	• Dependent on natural hydraulic gradient of free product. • Removal process takes longer time frames. Can not remove all the recoverable volume of free product. • Groundwater recovery and cleanup can not be initiated until free product removal is complete.	Deleted.
	Absorbent socks	• Same as above.	Deleted
	Skimmer pumps	• Same as above.	Deleted
	Vacuum enhanced extraction	• Vacuum enhances the hydraulic gradient of the free product. • Free product removal process takes relatively shorter time frames. • Free product, groundwater, and soil vapors can be extracted simultaneously.	Retained
Soil Treatment			
Ex situ	Soil removal and disposal Soil removal and treatment	. Soil excavation is not feasible because of the on-site facilities which may potentially have to be replaced.	Deleted
In situ	SVE	. Using vacuum enhanced extraction technology for SVE allows for simultaneous recovery of free product and contaminated groundwater.	Retained
	Biological degradation	. It may be cost efficient if natural attenuation is occurring. Otherwise this technology requires supply of nutrients and control over microbial growth.	Deleted
Groundwater Treatment *Ex situ*			
Extraction	Pumping	• Requires extraction of groundwater, free product and soil vapor in three different stages.	Deleted
	Vacuum enhanced extraction	• Contaminated groundwater, free phase petroleum product and contaminated soil vapor may be extracted simultaneously.	Retained
	Recovery trenches	• Excavation activities are restricted at the site.	Deleted

See notes at end of table.

Table 3-5 (Continued)
Selection of Technologies

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Component	Technology	Rationale	Decision
Treatment	Air stripping UV/OX Carbon adsorption	• Use of these technologies require installing capital intensive treatment systems. • Groundwater contamination is limited to total VOA, total naphthalenes and TRPH.	Retained
	Oily-waste collection and treatment system	• Emulsified fluids may be separated into oil and water. Separated water may be further treated at the oily waste treatment system.	Retained
Discharge	Infiltration galleries	• Subsurface soil at Facility 325 is permeable. Once groundwater is treated it may be discharged underground via infiltration galleries. Requires special permitting from the local and State regulatory agencies.	Retained
	Oily-waste collection and treatment system	• Base's oily waste collection and treatment system has the capacity to handle the extracted groundwater.	Retained
	Surface water	• Requires NPDES permit be maintained.	Deleted
In situ	Natural attenuation	• Evidence of natural attenuation based on three episodes of historical sampling.	Retained
	Enhanced biodegradation	• Requires supply of nutrients and control over the microbial growth.	Deleted
	Aquifer air sparging	. Very effective when combined with SVE. AAS is less costly than above ground treatment systems. However, free product removal should be complete before application of AAS.	Retained

Notes: SVE = soil vapor extraction.
UV/OX = ultraviolet light and oxidation.
VOA = volatile organic aromatic.
TRPH = total recoverable petroleum hydrocarbons.
NPDES = National Pollution Discharge Elimination System.
AAS = atomic absorption spectroscopy.

flexible to recover both the vapor phase and the liquid phase contaminants simultaneously.

- Exposure pathways for total VOA, total naphthalenes and TRPH in groundwater are very limited. With an exception of total VOA, contaminants of concern are below the monitoring only guidelines of 62-770, FAC. Hence, a separate treatment for groundwater is not warranted. However, cost effective enhancement to the selected soil and free-product technology may be proposed to accelerate the cleanup of total VOA in groundwater.

The recommended remedial alternative for Facility 325 soil and groundwater contamination at CSS Panama City is source abatement through a free-product monitoring and recovery program, SVE and groundwater monitoring. The remedial construction is also proposed to incorporate necessary components for future potential installation of an AAS.

4.0 RECOMMENDED REMEDIAL ACTION

The components of the remedial action at Facility 325 are as follows:

- vacuum enhanced extraction of free product, and limited extraction of groundwater, treatment of mixed fluids at the oily waste collection and treatment system;

- vacuum enhanced extraction of soil vapor, and treatment of soil vapor;

- installation of necessary piping for a future potential aquifer air sparging system; and

- groundwater monitoring.

4.1 VACUUM ENHANCED EXTRACTION SYSTEM. The VEE system at Facility 325 will be used to recover free product and soil vapor.

Components of a VEE system at Facility 325 include

- vacuum enhanced extraction wells (VEEWs),
- extraction well heads,
- piping network,
- vacuum pump,
- total fluids collection tank,
- vapor treatment,
- oil-water separator, and
- groundwater treatment system.

Figure 4-1 presents the schematic for the VEE system. VEE results in simultaneous extraction of soil vapor, free-phase petroleum hydrocarbons and a limited extraction of groundwater. Figure 4-2 presents a schematic of the well head for the VEE.

4.1.1 Technology Description

4.1.1.1 Free-Product Recovery Free-phase liquid and groundwater are extracted, using a draw-tube with its tip located at the oil-water interface. Location of the tip of the draw-tube is adjusted based on the depth to oil-water interface. A vacuum is initially applied to the draw-tube to begin removal of groundwater and free product. The draw-tube and the well casing are manifolded to the same vacuum source. High vacuum is applied to the draw-tube in order to lift the water and/or free product thus lowering the water table within the formation area of the recovery well. A vacuum applied to the inside the of the well bore hole also results in a positive uplift pressure on the water table, thereby increasing the hydraulic gradients of the fluids within the well.

The vacuum influence of the well increases the hydraulic gradient for flow of groundwater and product to the well, improving the ability of the recovery well to extract the free product.

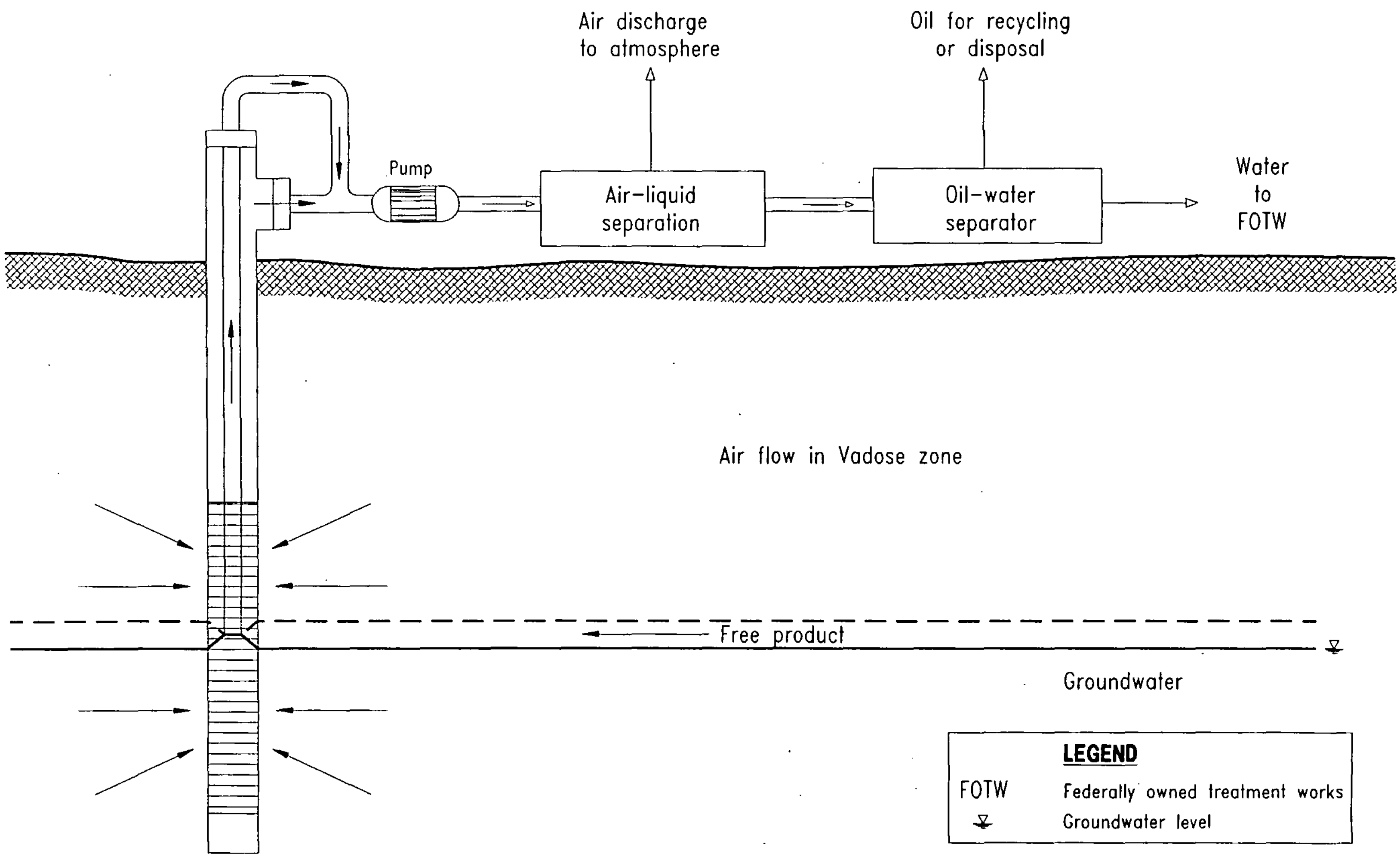

FIGURE 4-1
VACUUM ENHANCED EXTRACTION SYSTEM SCHEMATIC

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

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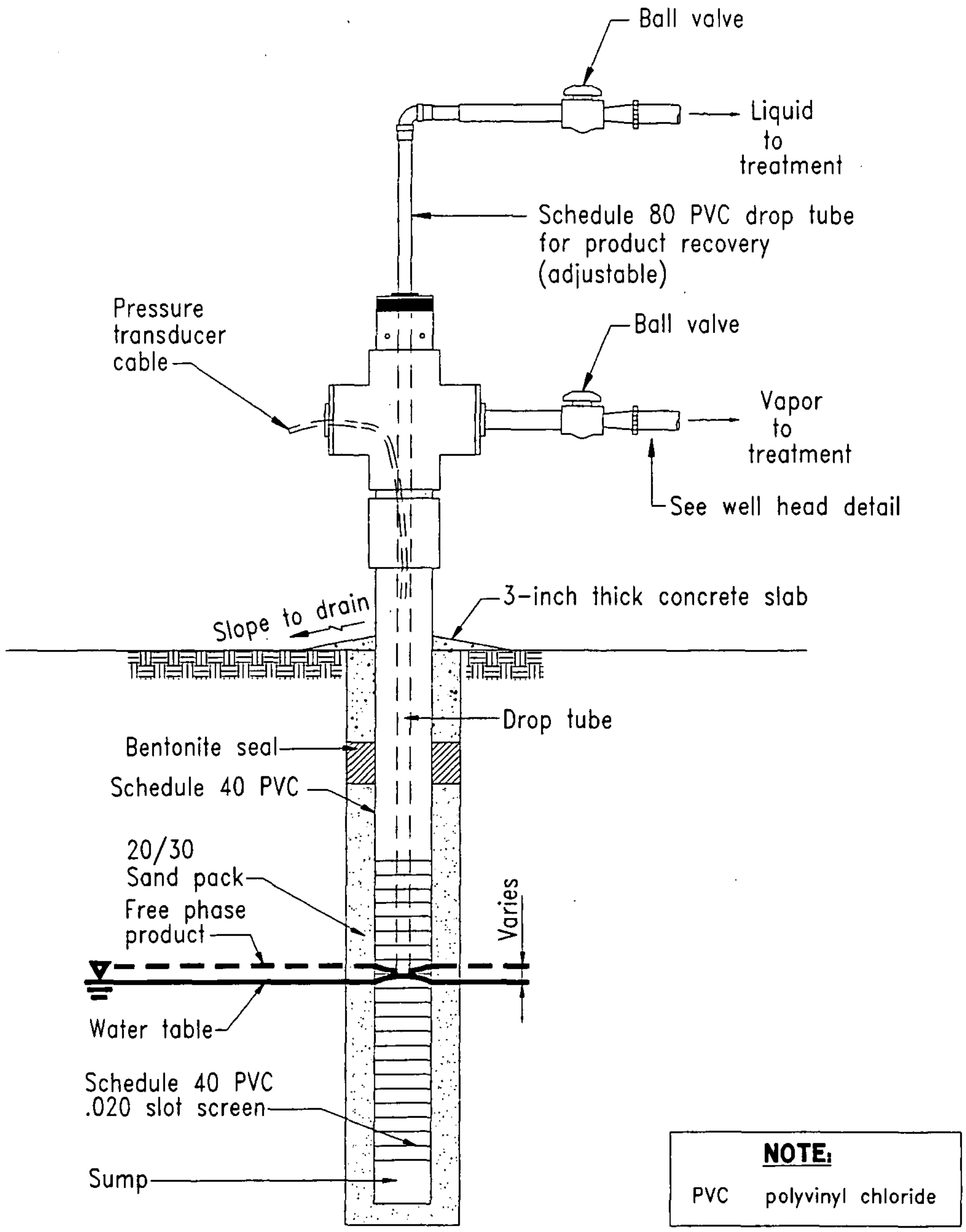

NOTE:

PVC polyvinyl chloride

VACUUM ENHANCED EXTRACTION WELL DETAIL

NOT TO SCALE

FIGURE 4-2
VACUUM ENHANCED EXTRACTION WELL DETAIL

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

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Implementation of the free product recovery program using VEE incidentally will result in the two additional following actions:

- Extraction of contaminated groundwater from the hot spot areas
- Increase in dissolved oxygen levels in the groundwater within the influence area of the VEE well

Pilot-scale tests conducted elsewhere using VEE have reported observation of an increase of 1 to 2 mg/l of dissolved oxygen at the end of an 8-hour VEE application at the recovery well (as described in Subsection 3.7.2, oxygen is one of the main nutrients required for sustaining natural attenuation of petroleum hydrocarbon components dissolved in groundwater).

4.1.1.2 **Soil Vapor Extraction** A vacuum applied to the inside of the well casing creates an air flow through the contaminated soil towards the extraction well. As the contaminated vapor is extracted from the subsurface, a concentration gradient is created between the soil vapor and the sorbed contaminants. As the imbalanced contaminant concentration attempts to reach an equilibrium, fresh air continues to enter the contaminated soils. The continual recharge of air sustains the on-going concentration gradient until the soils become clean.

4.1.2 System Design Vacuum enhanced extraction wells will be located to maximize the recovery of soil vapor from the vadose zone. Hence, the areal distribution of VEE wells will be based on the location of soil contamination and the radius of influence of each VEE well in the vadose zone. Each VEE well will also be installed to recover free product. Hence, the screen interval for each VEE well is selected to cover both unsaturated and saturated zones of the aquifer (see Table 4-1). The CAR has reported that the free product present at the site is expected to be in the form of small, isolated pockets. Therefore, it is anticipated that the areal distribution of VEE wells based on location of soil contamination will be sufficient to capture potential pockets of free product present at the water table.

4.1.2.1 **Free-Product Recovery** Free product has been observed in monitoring wells MW-8, MW-9, MW-15, MW-18, MW-23, and MW-26. Free product, if present at the site, is anticipated to be distributed in the form of isolated pockets within the capillary zone in an area common to the groundwater and soil contamination. Free-product recovery wells will be the same as the soil vapor extraction wells.

4.1.2.2 **Soil Vapor Extraction** Subsurface soil at Facility 325 consists of fine- to medium-grained sand with less than 10 percent of clay. Based on the hydraulic conductivity values estimated through slug tests conducted during the CA, the intrinsic permeability at this site is estimated to range between 10^{-7} cm^2 (10 Darcys) to 10^{-8} cm^2 (1 Darcy). Based on pilot scale and full scale studies conducted elsewhere for similar soil types and hydrogeological conditions, the vacuum radius of influence is selected as 35 feet. An estimate of vacuum drawdown, vapor flow rate, and the number of VEE wells required was calculated based on the site-specific data presented above.

Based on calculations presented in Appendix D, it is estimated that Facility 325 requires 5 VEE wells, with a total flow rate of 225 cubic feet per minute (ft^3/min) and a total vacuum of 5-25 inches of mercury column. These VEE wells

Table 4-1
Construction Details of VEE/AAS Wells

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

VEE/AAS Well ID	Depth to Groundwater (ft bls)	Screen Interval (ft bls)	Nearest Monitoring Well
VEE-1	3.65	2-10	MW-21
VEE-2	4.80	2-10	MW-23, MW-26
VEE-3	4.80	2-10	MW-18
VEE-4	4.60	2-10	MW-15
VEE-5	5.00	2-10	MW-10
AAS-1	4.70	25-30	None
AAS-2	4.70	25-30	None
AAS-3/MW-16D	4.85	25-30	MW-16D

Notes: VEE = Vacuum Enhanced Extraction.
AAS = aquifer air sparging.
ID = identification.
ft = feet.
bls = below land surface.
D = deep well.

are also designed to extract free product and groundwater. Hence, the vacuum pump selected for this system should operate under dry (100 percent soil vapor), wet (100 percent fluids) and mixed flow situations. The vacuum pump should also be capable of generating enough vacuum to extract soil vapor as well as free product and groundwater from the VEE well and carry the total fluids into the holding tank. Based on these requirements, the recommended vacuum pump for this site is an "Atlantic Fluidics, FLUID-VAC® liquid ring pump A300" or equivalent.

This liquid ring pump has a 20-horsepower motor and operates on 230 volt, 3-phase, alternating current, electric power. This system is capable of extracting soil vapor, free product, and groundwater simultaneously.

The liquid ring pump system (see Appendix D for details) will be skid mounted and equipped with pressure and vacuum gauges, adjustable pressure relief valve, a flow meter, and a thermometer. The vacuum pump will be explosion proof, it will be operated by a control panel located on the skid. The panel will actuate a shutdown of the blower if

- the liquid level in the seal reservoir of the liquid ring pump (see Figure 4-5) is at or below a low level sensor,
- thermometer on the liquid ring pump reads temperatures at or higher than those set by the pump manufacturer,
- the liquid level in the total fluids holding tank is at or beyond a high level sensor, and
- the liquid level in the temporary fluids storage tank is at or beyond a high level sensor.

In case of a shut off, the system will be serviced and the pump will be manually restarted.

VEE wells VEEW-1, VEEW-2, VEEW-3, VEEW-4, and VEEW-5 will be installed at the locations shown on Figure 4-3. Construction details of the VEE wells are included in Table 4-1. Figure 4-4 presents the construction details for VEE wells 1 through 5.

Figure 4-5 includes the piping and instrumentation diagram for the VEE system. Each VEE well will have two independent supply lines that are manifolded at the compound. Appropriate sampling ports, flow control valves, and flow meters will be installed on each vacuum supply line to facilitate selective operation of the VEE wells. A totalizer flow meter and totalizer sampling port will be installed after the manifold to monitor the overall efficiency of the soil vapor extraction and free-product recovery process. The vacuum source attached to the drop tube will be designed to provide a third source of vacuum to facilitate supply of vacuum to any of the monitoring wells for potential free-product recovery. Installing these features on the well head would facilitate utilizing any of the existing monitoring wells as a free-product recovery well, thus improving the overall efficiency of the VEE system. The pipes from each VEE well will be designed to carry soil vapor, free product and groundwater. The pipes from the VEE wells to the compound will be of 1 inch diameter Schedule 80 polyvinyl chloride (PVC). The main supply line connecting the manifold to the liquid ring pump will be of 4 inch diameter Schedule 80 PVC.

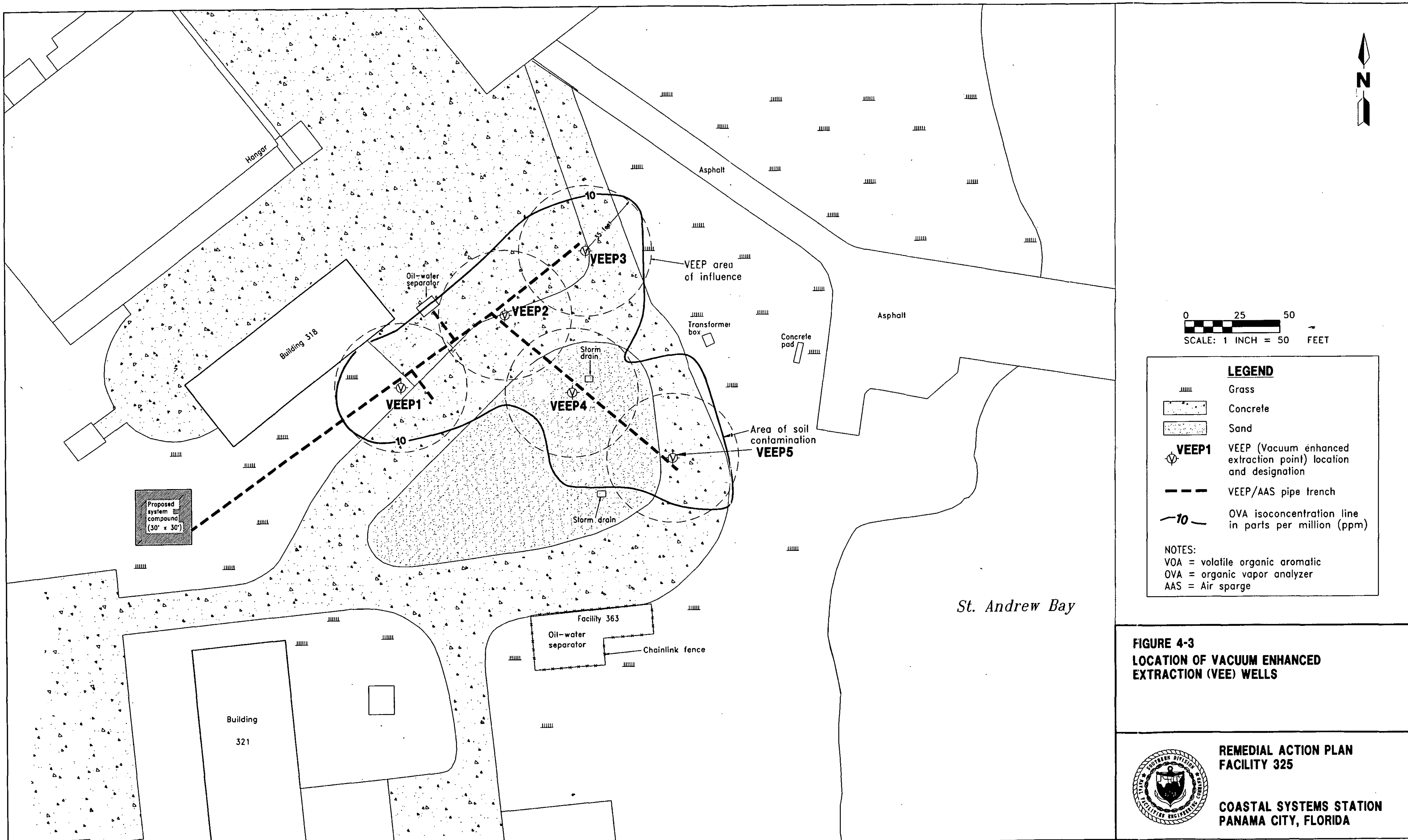
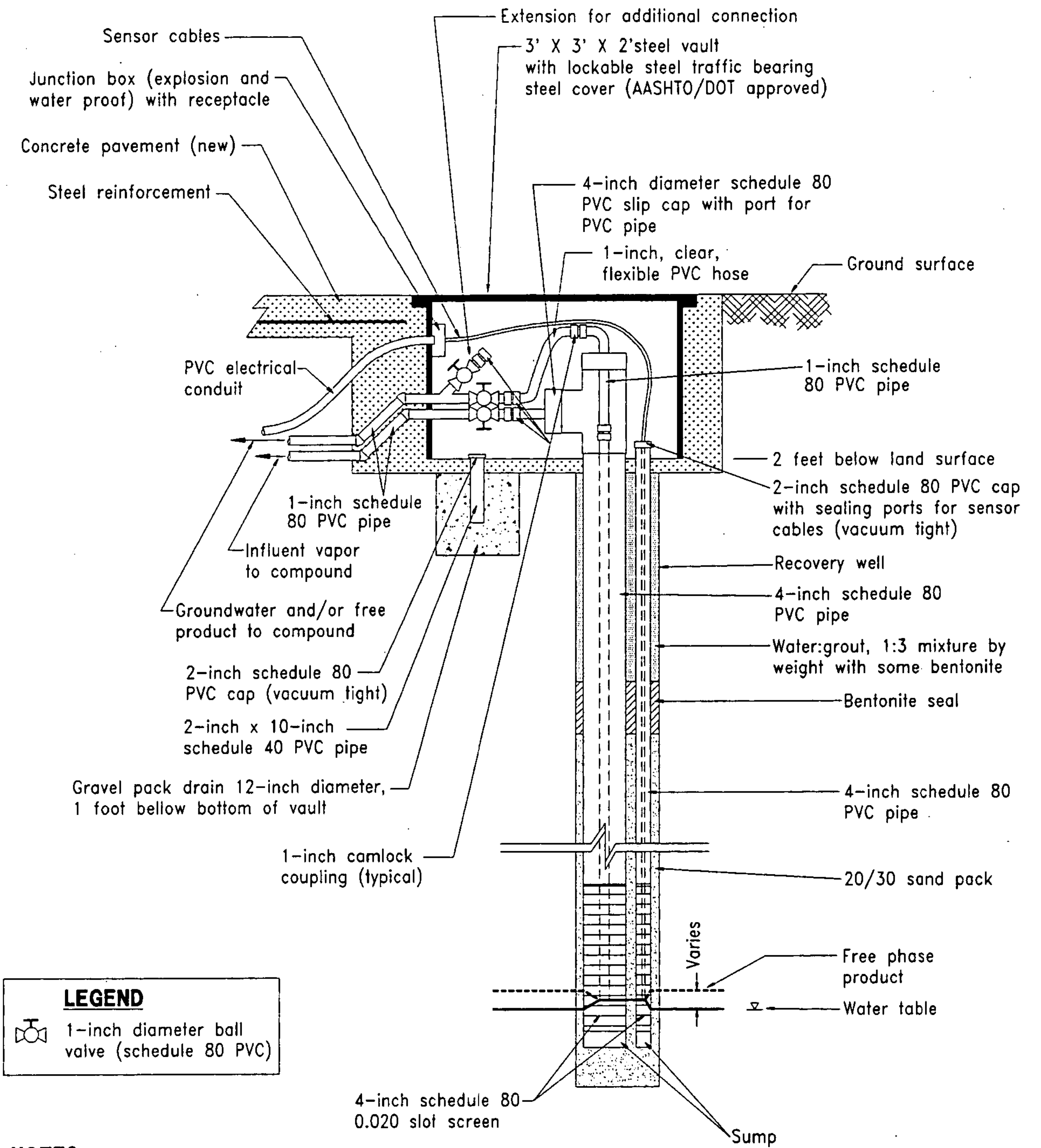


FIGURE 4-3
LOCATION OF VACUUM ENHANCED EXTRACTION (VEE) WELLS

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA



NOTES:

VEE = Vacuum enhanced extraction
PVC = Polyvinyl chloride
DOT = Department of Transportation
AASHTO = American Association of State Highway Transportation Officials

NOT TO SCALE

FIGURE 4-4
CONSTRUCTION DETAILS OF VEE WELLS 1,2,3,4 AND 5

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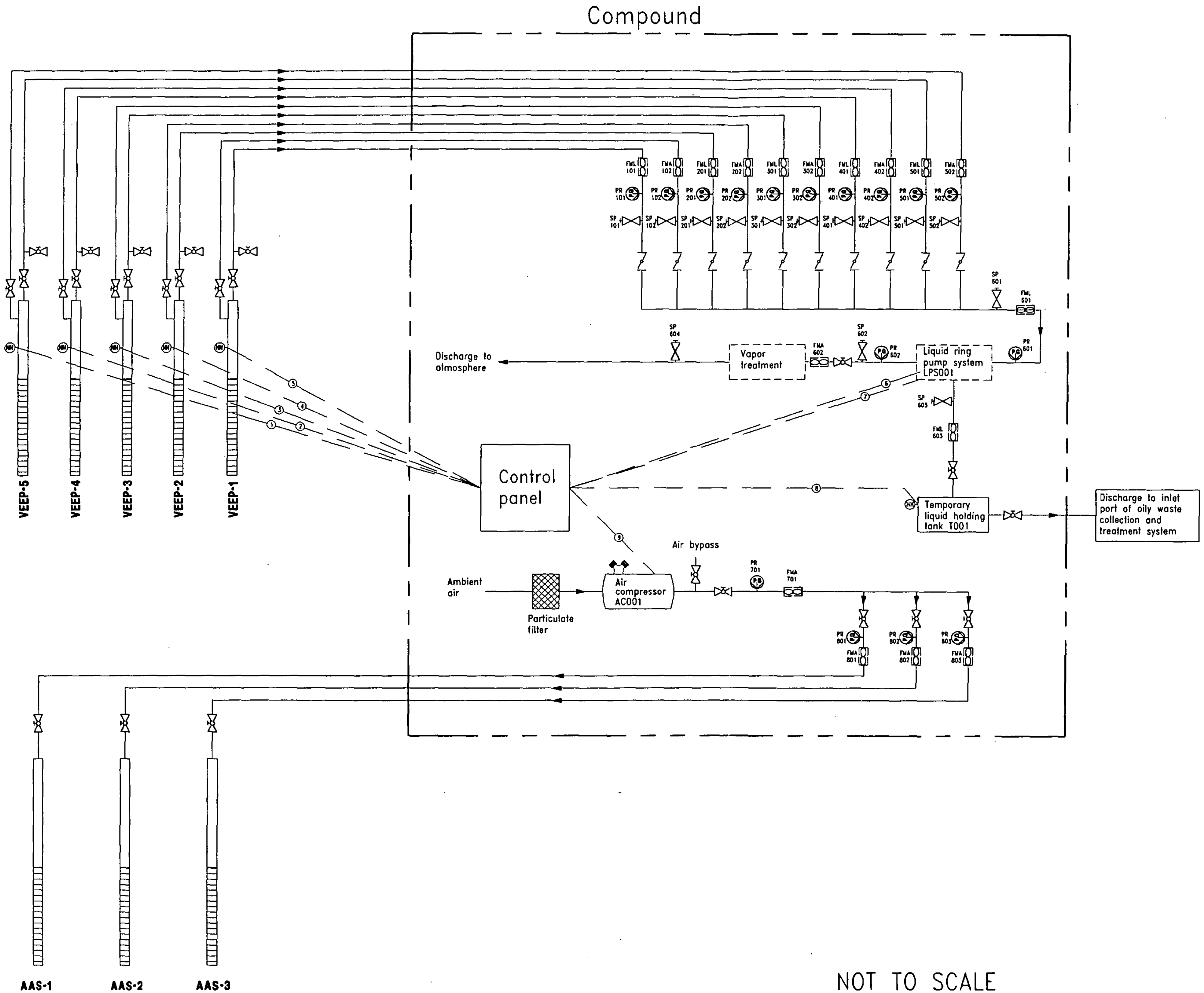
REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA



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LEGEND

- Ball valve
- Flow conrol valve (butterfly valve)
- Check valve
- Direction of flow
- FMA 501 Air flow meter with designation
- FML 501 Liquid flow meter with designation
- Water level sensor
- PR 501 Pressure guage with regulator and designation
- SP 501 Sampling port with designation
- Electric lines

ELECTRIC LINE DESIGNATIONS:

- ①②③④⑤ High water level sensor cables from VEE wells
- ⑥ High water level sensor cable from the surface water reservoir of the liquid-ring pump system
- ⑦ Temperature sensor cable from liquid-ring pump
- ⑧ High water level sensor cable from the temporary liquid holding tank
- ⑨ Temperature sensor cable from the air compressor

NOTES:
VEE = Vacuum enhanced extraction
AAS = Air sparge

FIGURE 4-5
VEE-AAS PIPING AND INSTRUMENTATION DIAGRAM

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

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Vacuum in the vadose zone will be monitored through existing monitoring wells MW-5, MW-7, MW-8, MW-10, MW-12, MW-20, MW-23, and MW-28 (construction details of these existing wells are included in Appendix D). These monitoring wells are located at varying radial distances from the VEE wells. Thus it is anticipated that the vacuum readings obtained on these wells will serve to establish the effective radius of influence from each of the VEE wells. These wells may also serve as air inlet wells for the vacuum system as needed.

A vapor extraction pilot study was not conducted prior to the preparation of this RAP; therefore, it will be necessary to conduct startup testing of the vapor extraction system to fine tune and adjust the vacuum and flow rate and monitor VOA continuous concentrations at the effluent port. The startup testing program will consist of a vacuum pumping test of up to 8 hours in which vacuum pressures and flow rates will be measured. Based on the results of this testing program, the extraction rates necessary to achieve remedial goals will be determined.

The overall performance of VEE will be evaluated based on the data obtained for the monitoring parameters listed below.

Free Product Recovery:

- Initial and final thicknesses of free product in source area and perimeter area monitoring wells
- Composition of total fluids collected at during extraction

SVE:

- Vapor flow rates from the recovery wells
- Vapor concentrations during application of VEE
- Vacuum readings at the well heads from source area and perimeter area wells during application of VEE

Groundwater Contamination Reduction at the Source Area Wells:

- Groundwater samples from source area and perimeter area wells
- Increase in dissolved oxygen concentrations in groundwater at the source area and perimeter area wells

Table 4-2 presents the data log for VEE.

4.2 AQUIFER AIR SPARGING. Contaminants of concern in groundwater at Facility 325 include benzene, total VOAs, PAHs, total naphthalenes and TRPH. The AAS system is proposed to cleanup benzene and total VOA in groundwater. This AAS system is anticipated to complement the previously proposed groundwater remediation components, including the limited extraction and treatment, and potential natural attenuation due to addition of oxygen to the subsurface environment during vacuum enhanced extraction.

Table 4-2
Vacuum-Enhanced Extraction Data Log

Remedial Action Plan, Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Site:

Date: | Vac-Truck Operator:

Logged By: | Checked By:

Time[1]	Applied Vacuum[2] (H_2O in.)			Vapor Flow Rate[3] (SCFM) at the Recovery Well	Vapor Concentration[4]	Well Head Vacuum[5] (H_2O in.)					Volume of Fluids[6] (gallons)		
	Total	Drop Tube	Well Casing	Total	Total	MW-4	MW-5	MW-6	MW-7	MW-12	Total	Water	FP

[1] Time:	Time at which the measurements are made	
[2] Applied Vacuum:	Vacuum measured at V1, V2, and V3	Use Vacuum Gauges
[3] Vapor Flow Rate:	Measured at V1	Use Anemometer
[4] Vapor Concentration:	Measured at V1	Use Tedlar Bags to collect Vapor Sample and measure with a VOA analyzer
[5] Well Head Vacuum:	Vacuum measured at monitoring wells	Use Vacuum Gauges
[6] Volume of Fluids:	Measured from the polyethylene tank	Use Oil Water Interface Probe

Notes: H_2O = water.
SCFM = standard cubic feet per minute.
FP = free product.
V1 = at Vacuum Pump.
V2 = at the drop tube.
V3 = at the well casing.
VOA = volatile organic aromatic.

As mentioned in the earlier sections, an AAS system will not be efficient if free product is present at the site. Due to the presence of free product at Facility 325, a flexible approach is adopted for the implementation of AAS.

- Install all the piping necessary for an AAS system to facilitate future addition of the air sparge wells and compressor unit.

- Implement free-product recovery program until there is no recoverable free product present in capillary zone.

- Evaluate the groundwater monitoring data for total VOA, benzene, and TRPH.

- If the free-product removal is complete and groundwater contamination continues to exist, then evaluate if AAS installation will accelerate cleanup of groundwater.

A complete system is designed and system details are presented in this RAP for the purposes of budgeting and allocating resources.

4.2.1 Technology Description AAS involves injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to vapor phase. The air is then vented through the unsaturated zone via soil vapor extraction. Additionally, the injected air will provide a source that should help biodegradation of volatile and less volatile components of hydrocarbons present in the saturated zone. AAS will be most effective for constituents of greater volatility and lower solubility and for soils with higher permeability. AAS should not be used if free product is present at the site. AAS can create groundwater mounding which could potentially cause free product to migrate and contamination to spread. Facility 325 has a single occurrence of free product at one of the monitoring wells (MW-26) located north east of the site. Currently, the only piping necessary for potential future installation of an AAS system will be installed at Site 325 along with the VEE system. Even though an air sparging system is proposed to be installed at Facility 325, its operation will be evaluated after removal of free product. At which time, a thorough review of groundwater monitoring data will be done to assess the advantages of adding the AAS system.

Typical components of an air sparging system include the following:

- Well orientation, placement and construction details
- Manifold piping
- Compressed air equipment
- Monitoring and controls

4.2.2 System Design Subsurface soil at Facility 325 consists of fine- to medium-grained sand with less than 10 percent of clay. Based on the hydraulic conductivity values estimated through slug tests conducted during the CA, the intrinsic permeability at this site is estimated to range between 10^{-7} cm^2 (10 Darcys) to 10^{-8} cm^2 (1 Darcy). Based on pilot scale and full scale studies conducted elsewhere for similar soil types and hydrogeological conditions, the air sparging radius of influence is selected as 25 feet. An estimate of air pressure, air flow rate, and the capacity of compressor for a given number of air sparge wells was calculated based on the site-specific data presented above.

Based on calculations presented in Appendix D, it is estimated that the installation of three air sparge wells will require a total flow rate of 30 cubic feet per minute (cfm) and a total air pressure of 8 pounds per square inch (psi). Two air sparge wells will be installed at locations presented on Figure 4-6. Table 4-1 includes the depth to groundwater table, extent of groundwater contamination, and the screen intervals for each of the air sparge wells. Figure 4-7 presents the construction details of air sparge wells for AAS-1, AAS-2, and AAS-3. Based on the calculations presented in Appendix D, the recommended compressor for this site is an "W.E.S. Inc., SS5040, 25-40 cfm at 15 psi, 3-phase alternating current, 230 volt system or equivalent.

Compressor (see Appendix D for details) will be skid mounted and equipped with pressure gauges, an adjustable pressure relief valve, a flow meter, and a thermometer. The compressor will be operated by a control panel located on the skid. The panel will actuate a shutdown of the compressor if the thermometer on the compressor reads temperatures at or higher than those set by the pump manufacturer. In case of a shut off, the system will be serviced and the compressor will be manually turned on.

Air sparge wells AAS-1, AAS-2, and AAS-3 will be installed at the locations shown on Figure 4-6. Air pressures in the saturated zone and dissolved oxygen concentrations will be monitored through existing monitoring wells MW-5, MW-7, MW-8, MW-10, MW-12, MW-20, MW-23, and MW-28 (construction details of these existing wells are included in Appendix D). These monitoring wells are located at varying radial distances from the air sparge wells. Thus, it is anticipated that the pressure readings obtained on these wells will serve to establish the effective radius of influence from each of the AAS wells.

An air sparging pilot study was not conducted prior to the preparation of this RAP; therefore, it will be necessary to conduct startup testing of the air sparging system to fine tune and adjust the air flow rate and monitor pressure changes at the surrounding monitoring wells. The startup testing program will consist of an air sparge test of up to 8 hours in which air pressures and flow rates will be measured. Based on the results of this testing program, the air flow rates necessary to achieve remedial goals will be determined.

4.3 TREATMENT OF MIXED FLUIDS. During implementation of free product and groundwater recovery, the total fluids collected in the holding tank of the liquid ring pump system will be discharged into a 1,000-gallon polyethylene observation tank, which is next to the oily-waste collection and treatment system. This tank will be connected to the oily-waste collection and treatment system. Mixed fluids are temporarily stored in the polyethylene tank to make a visual estimation of composition of fluids.

The oily-waste collection and treatment system at CSS Panama City consists of an oil-water separator and an oily-waste treatment plant. Contaminated groundwater will be treated at the oily-waste treatment plant.

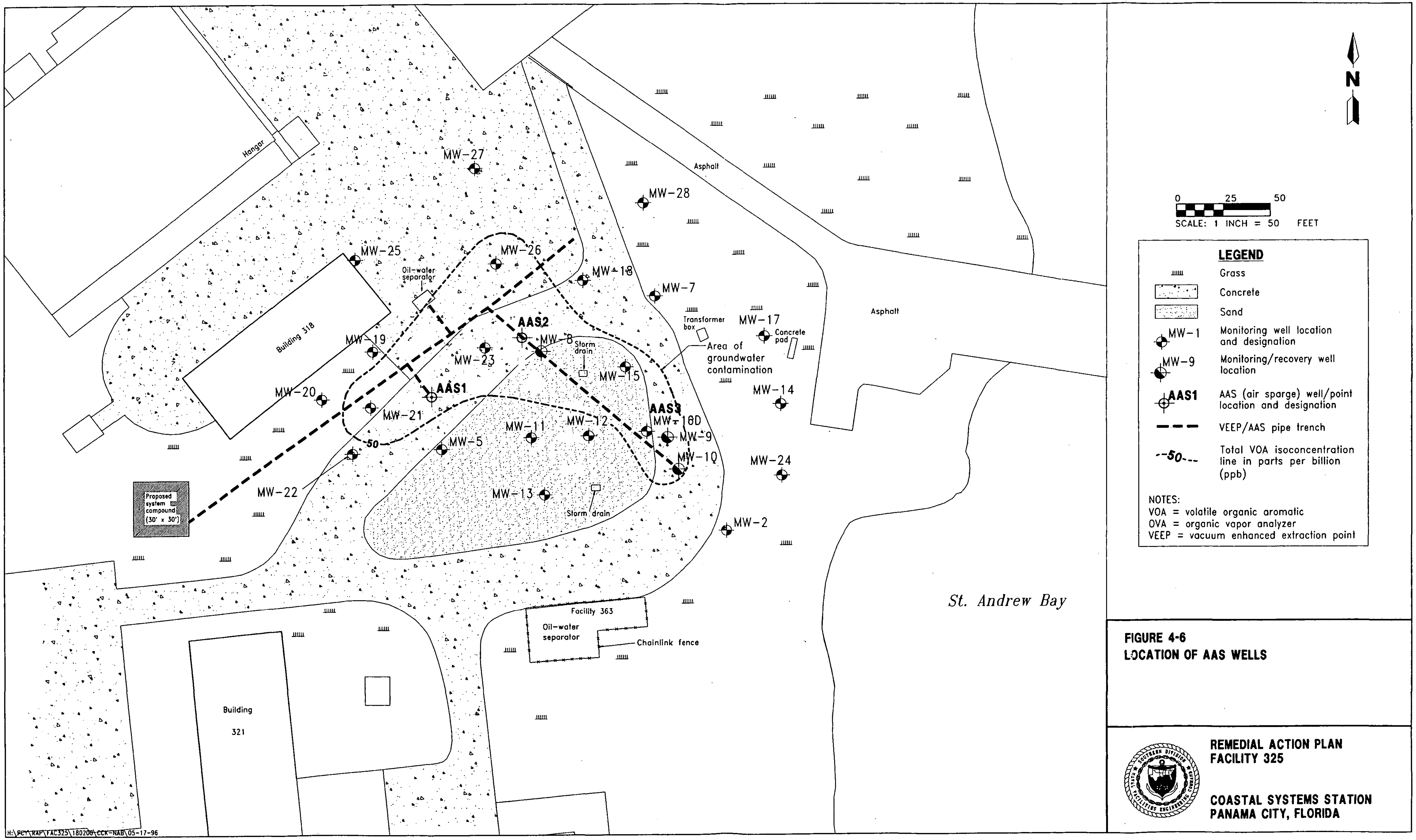
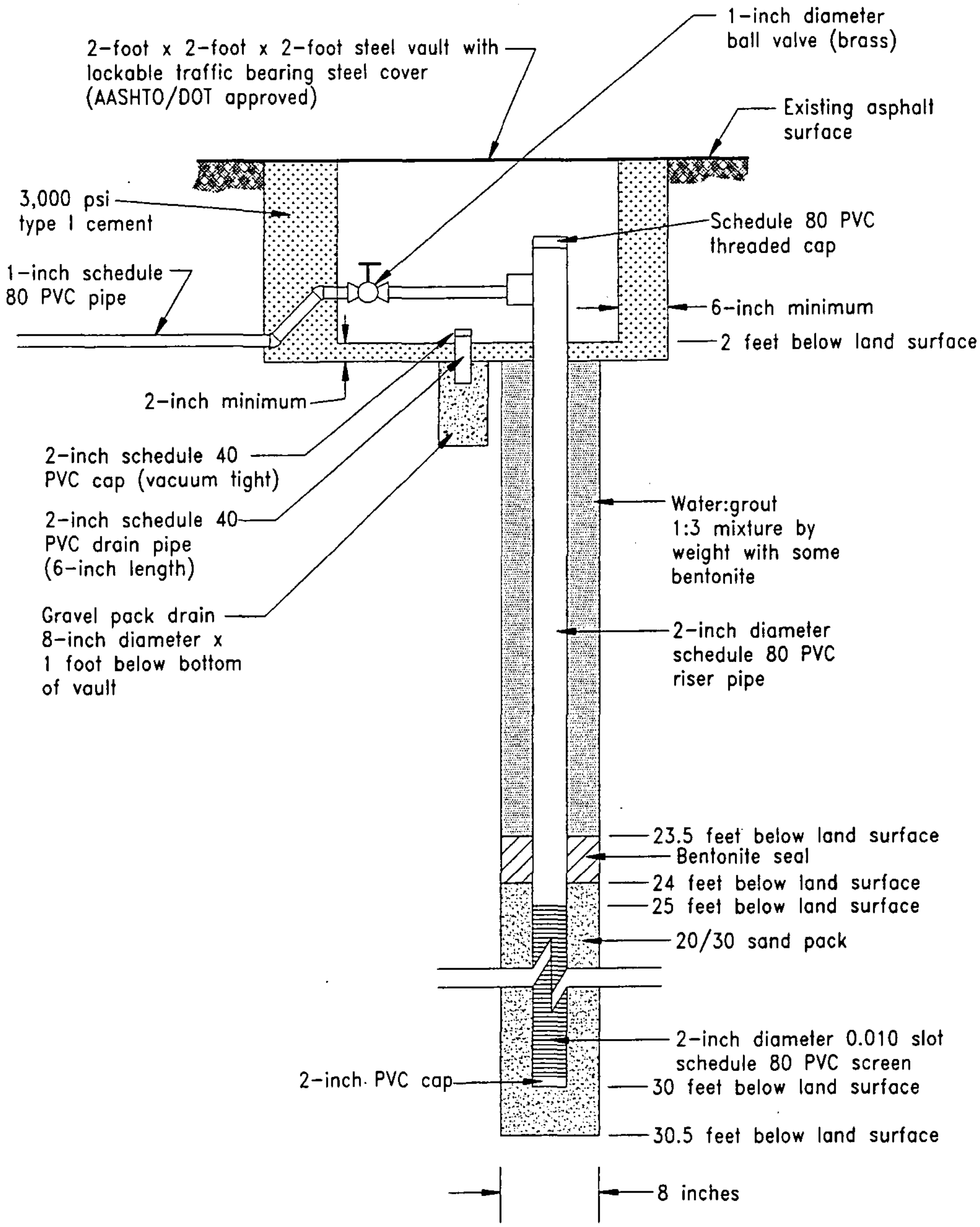


FIGURE 4-6
LOCATION OF AAS WELLS

REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA



NOT TO SCALE

NOTES:
PVC = Polyvinyl chloride
DOT = Department of Transportation
AASHTO = American Association of State Highway Transportation Officials
psi = Pounds per square inch
AAS = Aquifer air sparging

FIGURE 4-7
WELL CONSTRUCTION DETAILS OF AAS WELLS 1, 2 AND 3

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REMEDIAL ACTION PLAN
FACILITY 325

COASTAL SYSTEMS STATION
PANAMA CITY, FLORIDA

4.4 TREATMENT OF PETROLEUM HYDROCARBON VAPORS. Petroleum hydrocarbon vapors generated through SVE and air sparging systems are contained/treated at three different stages of their process flow (see Figure 4-1).

(1) Containment within the liquid ring of the liquid ring pump system.

(2) Containment with in the centrifugal scrubbers installed at the effluent port of the liquid ring pump system.

(3) Treatment within the solid phase granular activated carbon system installed at the effluent port of the centrifugal scrubbers.

The liquid ring pump system will extract vapor from VEE wells. These vapors will travel through the PVC pipelines into the system enclosure where by they pass through the liquid ring pump system. The liquid ring pump, which is also known as a true vacuum pump, consists of a single aluminum impeller that spins at a very low speed (700 revolutions per minute) inside an aluminum housing. The liquid ring is developed inside the pump housing and becomes the housing wall. The liquid used inside the pump is generally water, however, any suitable liquid can be used. These principle design characteristics available with liquid ring pumps minimize the risk for a spark to occur in the pump. As the product vapor enters the liquid ring pump, it is compressed on the housing wall of water. The discharge air and vapor, along with a portion of the pump's liquid supply, are then discharged to an unrestricted exhaust tower also known as centrifugal scrubber. The pump liquid supply that is discharged absorbs some of the vapor resulting in a reduced concentration of vapor at the effluent port of the scrubber system. Water from the liquid ring pump tower may be collected and treated along with the total fluids collected in the fluids collection tank. Vapors at the effluent port of the centrifugal scrubber will be treated before atmospheric discharge using two 2,000 pound. GAC vessels that will remove the volatile organic hydrocarbon compounds. Based on a flow rate of 225 scfm and an estimated concentration obtained using calculations included in Appendix D, the first two drums are expected to last approximately 30 days. Due to the substantial reduction of vapor concentrations with in the liquid ring pump system and an anticipated decline in the concentrations of vapors over time the GAC drums are expected to last longer. However, sufficient supply of carbon to last for the first 2 months of operation will be provided before the VEE system is turned on. Carbon delivery and replacement will be handled by a carbon vendor who will remove the spent carbon and regenerate the carbon through incineration at their facility. The SVE exhaust will be run through carbon in this manner for a minimum of 2 months as outlined in the "Guidance Manual for Review of Petroleum Remedial Action Plans, November 1990". Following the first 2 months of operation, data will be reported to evaluate if additional exhaust gas treatment will be required. Figure 4-5 presents the piping and instrumentation diagram for the VEE/AAS system at Facility 325.

4.5 SYSTEM STARTUP. Prior to the initiation of the free-product and groundwater recovery and monitoring program, groundwater from the source area and perimeter area monitoring wells will be collected for laboratory analyses as a baseline concentration for the monitoring program.

The proposed initial phase of site remediation involves SVE operation and implementation of free product monitoring and recovery program before activation of the AAS system. Soil vapor extraction and free-product recovery and limited groundwater extraction will be implemented simultaneously using a liquid ring pump via VEE. Once the free-product monitoring and recovery program indicates absence of free product, and SVE vapor concentrations reach asymptotic level, installation of aquifer air sparing wells will be evaluated.

The evaluation may lead to one of two of the following actions:

- If the evaluation indicates that installing an AAS system is economical for reducing total VOA concentrations in groundwater, the AAS wells will be installed and hooked up to a compressor of the designed size. The AAS system installation will be completed within 4 weeks after approval of the decision.

- If the evaluation indicates that the groundwater total VOA concentrations may be attenuated through natural processes of degradation, installation of an AAS system will not be warranted.

Operation of both systems will be monitored weekly for the first 3 months and monthly for the remainder of the year of operation. During these operational checks, data will be recorded such as vacuum pressures and exhaust flow rates, vapor concentration measurements, AAS injection pressure and flow rates, and hours of operation. These measurements will allow to optimize the efficiency of the remediation systems performance over time. Following the first year of operation, a new operation and maintenance schedule will be submitted to FDEP for review.

<u>4.6 SYSTEM MONITORING AND REPORTING</u>. To maximize and monitor system performance, monitoring during every extraction event is recommended.

<u>4.6.1 Free-Product Recovery</u> Free-product thickness and depth to groundwater will be measured on a weekly basis for the first 3 months, monthly for the remainder of the year in order to establish the presence or absence of free product at the site. Free-product and groundwater recovery will be continued until no recoverable free product is identified in any of the VEE wells for three consecutive quarters.

<u>4.6.2 Soil Vapor Extraction</u> On a weekly basis for the first 3 months and monthly basis for the remainder of the first year of operation, SVE emissions will be monitored for volatile organic hydrocarbons using an OVA or portable gas chromatograph. Vapor monitoring will be performed on the SVE airstream before entrapment in the liquid ring system, before carbon treatment, mid carbon treatment, and following carbon treatment so that carbon vessels can be changed out before system breakthrough. The monitoring schedule for the remaining term of remediation will be based on an evaluation of the first three months of data collected on the operation of the system.

The air emissions, after controls, (i.e., after the carbon treatment stage) will be monitored to meet the requirements of FDEP guidance levels (FDEP, February 1996). Samples shall be collected in a tedlar bag and analyzed by USEPA Method 25A to determine total VOC concentrations in the discharge air.

Air emissions will be monitored weekly for the first month of operation and monthly for the remainder of the year until vapor treatment is offline.

4.6.3 Aquifer Air Sparging Source area and perimeter area monitoring wells will be sampled and analyzed for Total VOAs, and benzene before AAS system startup. Before sampling, the water level and dissolved oxygen of each well will also be measured. This data will provide baseline for evaluating system performance through time. As stated in Rule 62-770.730, FAC, representative monitoring wells will be gauged monthly for the first 6 months and quarterly after that. Table 4-3 presents an outline of system sampling and monitoring for the first 2 years of system operation.

Table 4-3
Monitoring Plan Sampling Schedule

Remedial Action Plan
Facility 325
Coastal Systems Station Panama City
Panama City, Florida

Task	Monthly Monitoring							Quarterly Monitoring (1st year)			
	1	2	3	4	5	.	[1]12	1	4	7	10
Measure water levels	0	0	0	X	X	X	X	X	X	X	X
Measure free product thickness	0	0	0	X	X	X	X	X	X	X	X
Sample perimeter area wells[2]	X	X	X	X	X	X	X	X	X	X	X
Sample source area wells[3]	X	X	X	X	X	X	X	X	X	X	X
Soil Vapor Samples	0	0	0	X	X	X	X	X	X	X	X
Air Emissions Samples (USEPA Method 25A)	0	X	X	X	X	X	X	NA	NA	NA	NA

[1] Estimated maximum time to cleanup.
[2] Includes monitoring wells MW-2, MW-7, MW-12, and MW-14.
[3] Includes monitoring wells MW-8, MW-9, MW-10, MW-15, MW-21, MW-23, and MW-26.

Notes: 0 indicates task to be performed weekly in the given month.
X indicates task to be performed once in the given month.
NA = not applicable.

5.0 COST ESTIMATE

The cost estimate is inserted following Appendix E in those report copies that require it and has been omitted in others. This was done to facilitate Navy procurement requirements.

6.0 SCHEDULE

It is estimated that the VEE system installation and AAS piping installation will begin approximately 4 weeks following contract agreement. System installation is anticipated to take 6 weeks. Based on calculations included in Appendix D, the VEE/AAS system is anticipated to be operated for 2 years. Groundwater will be monitored for 1 year beyond termination of system operation.

7.0 DOCUMENTATION

A VEE, AAS system operation and groundwater operation, and maintenance plan will be provided at the time of installation and startup. The plan will provide all necessary information for the proper operation and maintenance of the product monitoring and recovery program. The plan will include, at minimum, the following:

- system startup instructions;
- system shutdown instructions;
- electricals and controls wiring diagram;
- system "as-built" drawings;
- equipment manufacturers' product operation manuals for each piece of equipment;
- equipment warranty and guaranty information;
- equipment service and repair vendor information;
- system troubleshooting guide;
- equipment and system maintenance schedule and checklist;
- material safety data sheets for materials used or being treated;
- monitoring schedule, including sampling frequency, sampling locations, required analyses, parameters for field measurement, vapor monitoring requirements, and vacuum measurement requirements; and
- instructions for maintaining a site activity log.

The manual will be assembled and bound in a manner suitable for use in the field.

8.0 PROFESSIONAL REVIEW CERTIFICATION

This RAP was prepared using standard engineering practices and designs. The plan for remediating this site is based on the information collected between October 1992 and April 1996, and engineering detailed in the text and appended in this report. If conditions are determined to exist that are different than those described, the undersigned professional engineer should be notified to evaluate the effects of any additional information on the design in this report.

This RAP was developed for the Facility 325, CSS Panama City, Florida, and should not be construed to apply to any other site.

Gopi Kanchibhatla
Professional Engineer
License No. 0049494

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REMEDIAL ACTION PLAN
FACILITY 325, CSS PANAMA CITY
PANAMA CITY, FLORIDA

APPENDIX A

EXTENT OF CONTAMINATION

Appendix A-I	Free Product
Appendix A-II	Soil
Appendix A-III	Groundwater

APPENDIX A-I

FREE PRODUCT

Appendix A-I

FREE PRODUCT THICKNESS ESTIMATE
CSS Panama City, Facility 325
Panama City, Florida

The measured free product thickness in a monitoring well is an apparent thickness and not the actual thickness of product in the soil. The primary factors which influence the degree of exaggeration in the apparent thickness include grain size and product density. Various methods for estimating the actual thickness are presented in Testa and Winegardner (1991). The following equation, referred to as CONCAWE in that text, may be used.

$$\frac{H}{h} = \frac{P_c^{wo}}{P_c^{oA}} \frac{\rho_o}{\rho_w - \rho_o}$$

where: H is the apparent thickness
h is the actual thickness
P_c^{wo} is the capillary pressure at the water-oil interface
P_c^{oA} is the capillary pressure at the oil-air interface
ρ_o is the density of the product
ρ_w is the density of water

The specific gravity of the product at this site is estimated to be 0.8. Therefore;

$$\rho_o = 0.8\rho_w \quad \textit{and} \quad \frac{H}{h} = \frac{P_c^{wo}}{P_c^{oA}} \frac{0.8\rho_w}{\rho_w - 0.8\rho_w} = \frac{P_c^{wo}}{P_c^{oA}} \frac{0.8}{1 - 0.8} = 4 \frac{P_c^{wo}}{P_c^{oA}}$$

Assuming the capillary pressures at the water-oil and oil-air interfaces are equal;

$$\frac{H}{h} \approx 4 \frac{P_c^{wo}}{P_c^{oA}} \approx 4 \quad \textit{or} \quad h \approx \frac{H}{4}$$

The product thickness is directly related to the volume of product contaminated soil, therefore, using the above equation, and assuming the porosity of the soil to be 0.25, the volume of the product is estimated as 550 gallons.

This estimate is consistent with actual measurements referenced in the text and is considered appropriate for this site.

Reference: Testa, S.M., and Winegardner, D.L., 1991, Restoration of Petroleum Contaminated Aquifers: Lewis Publishers, Chelsea, Michigan, 269 p.

Appendix A–I

FREE PRODUCT VOLUME CALCULATION
CSS Panama City, Facility 325
Panama City, Florida

PROJECT:	CSS PANAMA CITY, Facility 325	CHECKED BY:	
DATE:	08MAY1996	ENGINEER:	KGK

The estimated thickness and extent of product at Facility 325 is illustrated in Figure 3.
In April 27, 1996 free product was detected in MW–26 with a thickness of 0.52 ft, and in several other wells with a thickness ranging between 0.1 ft and 0.02 ft. The volume of actual free product saturated soil is estimated in the table using the average end area method.

Apparent Thickness (ft)	Actual Thickness	Area (ft^2)	Average Area (ft^2)	Incremental Volume (ft^3)	Cumulative Volume (ft^3)
0.52	0.130	0	0	0.000	0.00
0.50	0.125	707.14	353.57143	1.768	1.77
0.00	0.000	3712.50	2209.8214	276.228	278.00

V	Volume of soil saturated with product:	279.76	ft^3	
n	Porosity	0.25		assumed
nV	Free Product Volume	69.94	ft^3	
	Conversion of above	523.23	gallons	

APPENDIX A-II

SOIL

Appendix A-II

JP-5 Parameter Estimate

DATE: MAY 8, 1996 | ENGINEER: KGK | CHECKED BY:

Compound	Molecular Weight	Vapor Pressure	Mass Fraction	Boiling Point	Water Solubility	Kow	Calculated Henry's Law Const	Weighted Hc	Koc	Calculated Koc	Weighted Koc
		atm		C	mg/l		atm*m^3/mole				
2-methylpentane	86.2	0.21	0.07	60	14	6457	1.293	0.089217	3830	3830	264.27
3-methylpentane	86.2	0.2	0.04	64	13	6457	1.326153846	0.047741538	3830	3830	137.88
n-hexane	86.2	0.16	0.07	68.7	13	8710	1.060923077	0.074264615	3830	3830	268.1
benzene	78.1	0.1	0.15	80.1	1780	135	0.00438764	0.000640596	65	65	9.49
toluene	92.1	0.029	0.15	110.6	535	490	0.004992336	0.000728881	240	240	35.04
ethylbenzene	106.2	0.0112	0.15	136.2	152	1400	0.007818276	0.001141468		863.2	126.03202
o-xylene	106.2	0.0007	0.15	144	175	890	0.000400526	5.84768E-05	700	700	102.2
napthalene	128.2	0.0001	0.11	218	33	1738	0.000543879	5.8195E-05	962	962	102.934
1-methylnaphthalene	142.2	5E-05	0.07	244.6	25	7413	0.0002844	1.96236E-05	3570	3570	246.33
2-methylnaphthalene	142.2	5E-05	0.07	241	27	7943	0.000263333	0.00001817	3570	3570	246.33
			1.00				Weighted Average	0.213888564	Weighted Average K		1538.606

Appendix A-II
TOTAL MASS OF HYDROCARBON
IN THE UNSATURATED SOIL ZONE

PROJECT NAME: CSS Panama City, Facility 325, Panama City, Florida

MASS OF CONTAMINANT

DATE: 4/19/95 ENGINEE KGK CHECKED BY:

Symbol	Description	Incremental Quantities 1	2	3	4	5	6	7	8	9	10	Total Quantity	Units
Vol Total	TOTAL VOLUME OF CONTAMINATED SOIL WATER AND AIR	84076	29041	11178	4421	1882	1450	312	29	0	0		ft^3
Ca	AVERAGE AIR OVA CONCENTRATION	275	750	1250	1750	2250	2750	3250	3750	4250	4750		ppm
Vol Air	VOLUME OF CONTAMINATED AIR	18917	6534	2515	995	423	326	70	7	0	0		ft^3
Mass Air	MASS OF CONTAMINATED AIR	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0		kg
Hc	ESTIMATED JP-5 HENRY'S LAW CONSTANT	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21		atm*m^3/mole
Cw	WATER CONTAMINATION CONCENTRATION	1309.52	3571.43	5952.38	8333.33	10714.29	13095.24	15476.19	17857.14	20238.10	22619.05		mg/l
Vol Soil	VOLUME OF CONTAMINATED SOIL	63057	21780.75	8383.5	3315.75	1411.5	1087.5	234	21.75	0	0		ft^3
Sd	DEGREE OF SATURATION	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		unitless
Vol Water	VOLUME OF CONTAMINATED WATER IN SOIL	16478.9	5692.036	2190.888	866.516	368.872	284.2	61.152	5.684	0	0		gal
Mass Water	MASS OF CONTAMINANT IN WATER	81.67843	76.94413	49.36019	27.33136	14.95908	14.08651	3.582124	0.384178	0	0		kg
Koc	ESTIMATED JP-5 PARTITIONING COEFFICIENT	1539	1539	1539	1539	1539	1539	1539	1539	1539	1539		l/g
foc	FRACTION OF ORGANICS	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060		%
n	POROSITY	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		dimensionless
Kd	DISTRIBUTION COEFFICIENT	0.9234	0.9234	0.9234	0.9234	0.9234	0.9234	0.9234	0.9234	0.9234	0.9234		dimensionless
W	UNIT WEIGHT OF SOIL	150	150	150	150	150	150	150	150	150	150		lb/ft3
Ka	SORBED TO DISSOLVED RATIO	6.659	6.659	6.659	6.659	6.659	6.659	6.659	6.659	6.659	6.659		dimensionless
Mass Soil	MASS OF CONTAMINANT IN SOIL	543.9077	512.3813	328.6961	182.0032	99.61451	93.80396	23.85385	2.55829	0	0		kg
Mass Total	TOTAL MASS OF HYDROCARBON	625.7334	589.4642	378.1453	209.3839	114.6006	107.9159	27.44243	2.94316	0	0	2055.629	kg

APPENDIX A-III

GROUNDWATER

Appendix A-III
Summary of Groundwater Sample Laboratory Analysis, October 1992 through October 1995

Remedial Action Report
Facility 325, Coastal Systems Station
Panama City, Florida

	Applied Standard	MW-1		MW-2			MW-3		MW-4		MW-5			
		1992	1993	1992	1992 Dup	1993	1992	1993	1992	1993	1992	1993	1993 Dup	1995
Benzene	[1]50	ND	ND	5	6	ND	ND	2	ND	1	ND	ND	ND	ND
Toluene		ND	ND	ND	ND	ND	ND	ND	ND	8	ND	ND	ND	ND
Ethylbenzene		ND	ND	19	21	2	ND	8	ND	59	3	ND	ND	ND
Xylenes		ND	ND	19	22	3	ND	7	ND	160	6	ND	ND	ND
Total VOA	[1]50	ND	ND	43	49	5	ND	17	ND	228	9	ND	ND	ND
MTBE	[2]50	ND	ND	ND	ND	ND	1	ND	ND	ND	ND	ND	ND	ND
1,1-DCA	[2]700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DCB	[2]75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		70	ND	ND	82	ND	ND	17	ND	33,000	8	ND	ND	ND
1-Methyl-naphthalene		22	ND	ND	25	ND	ND	8	ND	50,000	9	ND	ND	ND
2-Methyl-naphthalene		16	ND	ND	16	ND	ND	ND	ND	50,000	7	ND	ND	ND
Total naphthalenes	[1]100	108	ND	ND	123	ND	ND	25	ND	133,000	24	ND	ND	ND
Acenaphthylene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRPH	[1]5	ND	ND	ND	ND	ND	ND	ND	2	15,000	ND	ND	ND	ND
Lead	[1]50	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	2.2

See notes at end of table.

Appendix A-III (Continued)
Summary of Groundwater Sample Laboratory Analysis, October 1992 through October 1995

Remedial Action Report
Facility 325, Coastal Systems Station
Panama City, Florida

	Applied Standard	MW-6		MW-7			MW-8	MW-9	MW-10	MW-11	MW-12
		1992	1993	1992	1993	1995	1995	1995	1995	1995	1995
Benzene	[1]50	2	5	ND	ND	ND	12	ND	ND	ND	1.0
Toluene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene		5	34	ND	ND	ND	71	26	20	ND	35
Xylenes		2	31	ND	ND	ND	58	25	32	ND	2.1
Total VOA	[1]50	9	70	ND	ND	ND	141	51	52	ND	38
MTBE	[2]50	1	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DCA	[2]700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DCB	[2]75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		42	110	ND	ND	2.3	420	130	98	ND	28
1-Methyl-naphthalene		26	40	ND	ND	1.4	170	38	34	ND	7.4
2-Methyl-naphthalene		25	35	ND	ND	ND	160	53	32	ND	29
Total naphthalenes	[1]100	93	185	ND	ND	3.7	750	221	164	ND	64
Acenaphthylene		ND	ND	ND	ND	1.5	30	7.5	1.8	ND	17
Acenaphthene		ND	ND	ND	ND	ND	18	2.3	2.4	ND	1.6
Fluorene		ND	ND	ND	ND	2.6	9.2	7.1	6.6	ND	3.1
Phenanthrene		ND	ND	ND	ND	ND	ND	ND	1.9	ND	1.4
Anthracene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRPH	[1]5	ND	ND	ND	ND	ND	1.4	6.1	2.0	ND	8.3
Lead	[1]50	8	ND	8	ND	ND	ND	ND	1.2	1.2	ND

See notes at end of table.

Appendix A-III (Continued)
Summary of Groundwater Sample Laboratory Analysis, October 1992 through October 1995

Remedial Action Report
Facility 325, Coastal Systems Station
Panama City, Florida

	Applied Standard	MW-13	MW-14	MW-15	MW-16D	MW-17	MW-18	MW-19	MW-20	MW-21	MW-21 Dup	MW-22	MW-23
		1995	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995
Benzene	[1]50	ND	ND	2.4	ND	2.7	ND	ND	ND	ND	ND	ND	20
Toluene		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene		ND	1.7	34	ND	6.2	1.6	10	ND	43	ND	ND	71
Xylenes		ND	ND	25	ND	ND	2.0	14	ND	84	3.9	ND	60
Total VOA	[1]50	ND	1.7	61	ND	9.9	3.6	24	ND	127	3.9	ND	151
MTBE	[2]50	1.1	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DCA	[2]700	ND	ND	ND	ND	ND	5.0	ND	ND	ND	ND	ND	ND
1,4-DCB	[2]75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		ND	7.2	110	1.7	20	32	5.3	ND	6.1	53	ND	400
1-Methyl-naphthalene		ND	3.3	53	1.7	4.5	16	2.4	ND	8.4	67	ND	120
2-Methyl-naphthalene		ND	4.8	45	1.0	10	19	3.5	ND	28	56	ND	94
Total naphthalenes	[1]100	ND	15	208	4.4	35	67	11	ND	43	176	ND	614
Acenaphthylene		ND	7.3	14	ND	2.3	2.6	ND	ND	5.2	3.8	ND	11
Acenaphthene		ND	19	10	ND	4.0	2.4	ND	ND	1.2	ND	ND	11
Fluorene		ND	6.4	22	ND	4.1	5.8	ND	ND	8.0	9.8	ND	ND
Phenanthrene		1.4	1.9	13	ND	1.3	1.3	ND	ND	5.9	3.4	ND	ND
Anthracene		ND	ND	7.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRPH	[1]5	1.0	1.5	3.1	ND	ND	1.9	ND	ND	1.7	1.5	1.2	1.0
Lead	[1]50	ND	ND	ND	9.1	ND	ND	2.1	1.1	ND	ND	1.2	ND

See notes at end of table.

Appendix A-III (Continued)
Summary of Groundwater Sample Laboratory Analysis, October 1992 through October 1995

Remedial Action Report
Facility 325, Coastal Systems Station
Panama City, Florida

	Applied Standard	MW-23 Dup	MW-24	MW-25	MW-26	MW-26 DUP	MW-27	MW-28	Facility 363 MW-2
		1995	1995	1995	1995	1995	1995	1995	1995
Benzene	[1]50	18	ND	ND	11	6.0	ND	ND	ND
Toluene		ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene		67	ND	ND	58	33	ND	ND	ND
Xylenes		59	ND	ND	74	40	ND	ND	ND
Total VOA	[1]50	135	ND	ND	143	79	ND	ND	ND
MTBE	[2]50	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DCA	[2]700	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DCB	[2]75	ND	ND	1.0	ND	ND	ND	ND	ND
Naphthalene		330	ND	ND	140	150	ND	ND	ND
1-Methyl-naphthalene		100	ND	ND	60	69	ND	ND	ND
2-Methyl-naphthalene		76	ND	ND	45	46	ND	ND	ND
Total naphthalenes	[1]100	506	ND	ND	245	265	ND	ND	ND
Acenaphthylene		ND	ND	ND	17	31	ND	ND	ND
Acenaphthene		10	4.5	ND	11	4.1	ND	ND	ND
Fluorene		ND	2.0	ND	3.1	5.7	ND	ND	ND
Phenanthrene		ND	2.5	ND	ND	2.6	ND	ND	ND
Anthracene		ND	ND	ND	ND	ND	ND	ND	ND
TRPH	[1]5	1.7	4.0	ND	3.3	6.1	ND	ND	ND
Lead	[1]50	ND	ND	ND	ND	ND	ND	1.3	ND

[1] State NFA or MO target level for Class G-II groundwater and no potable wells within 0.25 mile (FDEP, May 1994).
[2] Groundwater guidance concentration (FDEP, June 1994).

Notes: Concentrations are in parts per billion except TRPH, which is reported in parts per million.
Total VOA = the sum of benzene, toluene, ethylbenzene, and xylenes.
Total naphthalenes is the sum of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.

Dup = Duplicate.	1,4-DCB = dichlorobenzene.
ND = not detected.	TRPH = total recoverable petroleum hydrocarbons.
VOA[2] = volatile organic aromatic.	NFA = no further action.
MTBE = methyl tert-butyl ether.	MO = monitoring only.
1,1-DCA = dichloroethane.	FDEP = Florida Department of Environmental Protection.

APPENDIX B

IRA SUMMARY REPORTS

006963

Bechtel

Oak Ridge Corporate Center
151 Lafayette Drive
P.O. Box 350
Oak Ridge, Tennessee 37831-0350

Facsimile: (615) 220-2100

SEP 21 1995

Florida Department of Environmental Protection
Division of Waste Management
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Attention: Eric Nuzie

SUBJECT: Bechtel Job No. 22567
Department of the Navy Contract No. N62467-93-D-0936
UST CLOSURE ASSESSMENT FORM, COASTAL SYSTEMS STATION, PANAMA CITY, FLORIDA
Subject Code: 7560

Dear Eric:

Bechtel Environmental, Incorporated is performing work under the U.S. Navy's Remedial Action Contract (RAC) at Coastal Systems Station, Panama City, Florida in coordination with ABB Environmental Services, Inc. (ABB-ES) who is performing work under the Navy's Comprehensive Long-Term Environmental Action Navy (CLEAN) contract. Part of this work involved removal of five USTs at Site 325, in conjunction with an IRA for free product recovery and contaminated soil removal. Enclosed is a completed Closure Assessment Form covering removal of one of the five USTs and approximately 550 feet of pipeline trench with 4-inch supply and return pipelines. The Closure Assessment for the other four USTs and the IRA reporting information were reported to your office under separate cover by ABB-ES.

Three of the USTs that were removed were regulated 20,000 gallon JP-5 storage tanks situated together in one tank pit, for helicopter refueling. There were two separate water separation/filtration systems on the helicopter fueling system, one near the tank pit, and one at the helicopter refueling pantograph at the flight line, approximately 550 feet away from the tank pit. Each of these two systems had a 300 gallon UST for collection of water that was removed from the fuel.

A Storage Tank Registration Form [DER form #17-761.900(2)] was filed to provide 30 day-written notification prior to closure of the five tanks (copy enclosed) and incorrectly listed the waste water USTs as waste oil tanks. These two tanks may have been previously registered as petroleum storage tanks, although they were in fact non-regulated tanks because they contained only *de minimus* quantities of petroleum contamination in the water. Because they were not regulated tanks, there were no compliance monitoring wells associated with them.

ACTION REQ'D [ ] YES	[ ] NO	DUE DATE _______
RESPONSE TO CHRON NO. _______		

The enclosed sketch depicts the site plan, with the oily water tank reported on this Closure Assessment Form shown as tank #324. The approximately 550 foot-long fuel lines (supply and return) are also shown on this sketch, running from the "Pump Truck and Loading Station" to the "Helicopter Refueling Station." These two 4-inch pipelines were removed as part of the system closure, and will be replaced with secondary-contained pipeline by others as part of the overall system replacement/upgrade when new tanks are installed. The fuel delivery pantograph and fuel filtration system were also completely removed and portions salvaged for reuse in the new system.

There had been no reported releases from the hydrant system prior to this closure, and no evidence of releases or spills was detected during the closure. No contaminated soil was encountered and, therefore, none was removed as a part of the closure of this UST and the fuel pipeline. BEI performed soil screening during the pipeline system removal using headspace analysis with an OVA equipped with a flame ionization detector, following the procedures outlined in Florida Department of Environmental Protection, Pollutant Storage Tank Closure Assessment Requirements, February, 1994. Soil samples were collected from soil borings every 20 feet along the length of the pipeline and screened using headspace analysis. Similar samples were collected from the four corners and bottom center of the 300 gallon waste water UST pit after the tank was removed. None of the soil screening samples indicated the presence of any VOCs.

Due to remaining soil and groundwater contamination at the area near the three 20,000 gallon fuel storage tanks, a site assessment is being performed by ABB-ES which will be reported separately in the future. Temporary monitoring wells will be installed by ABB-ES in the areas of suspected groundwater contamination, and additional soils samples will be collected as a part of that site assessment.

If you have any questions or comments concerning this report, please contact me at (423) 220-2603.

Sincerely,

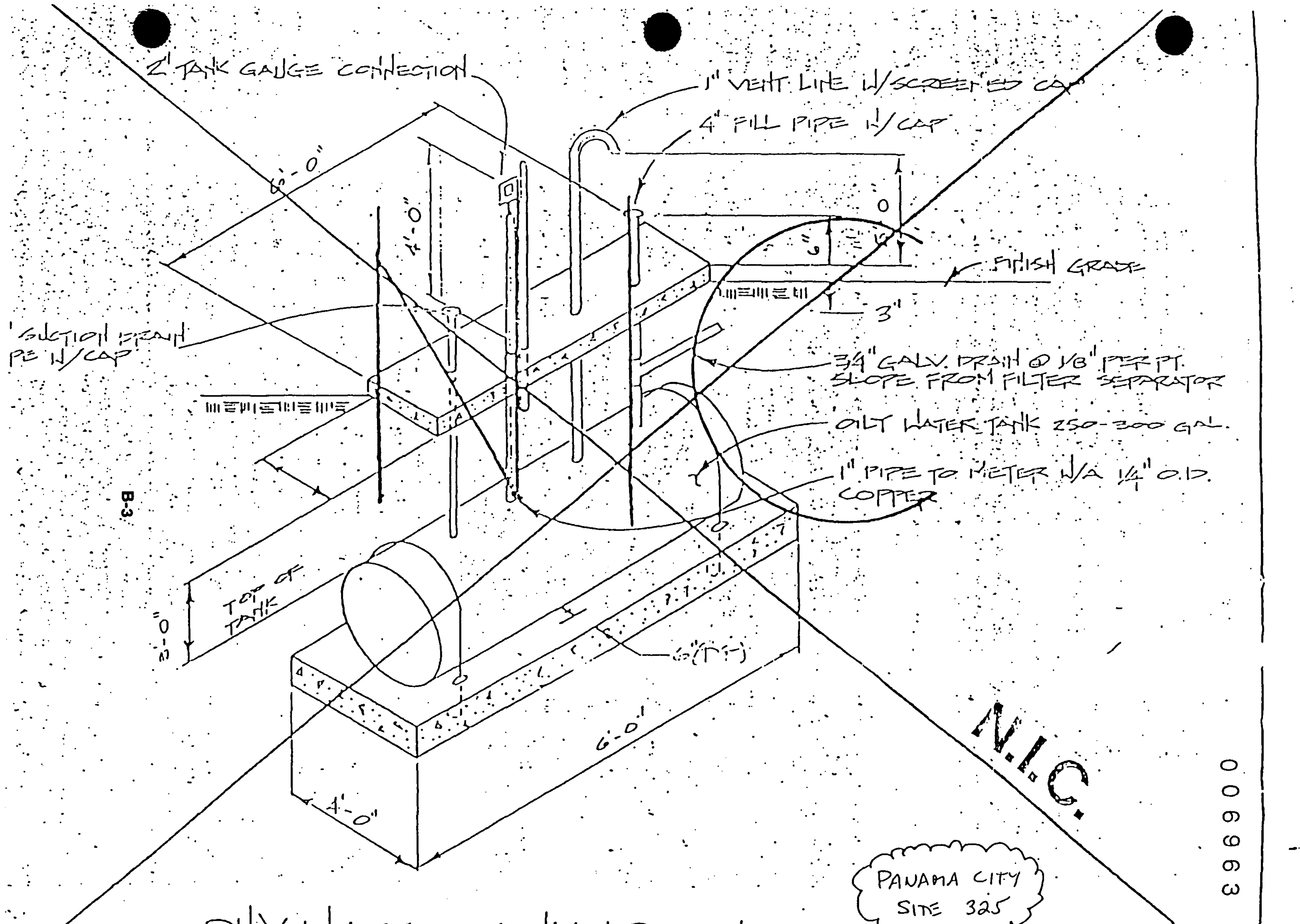
Steve W C Cowan

Steve Cowan
Project Manager

TMC:dcm:LR0352

Enclosures: As stated

cc: Gabe Magwood, SOUTHDIV RPM
Jay Koch, ABB-ES (Tallahassee)



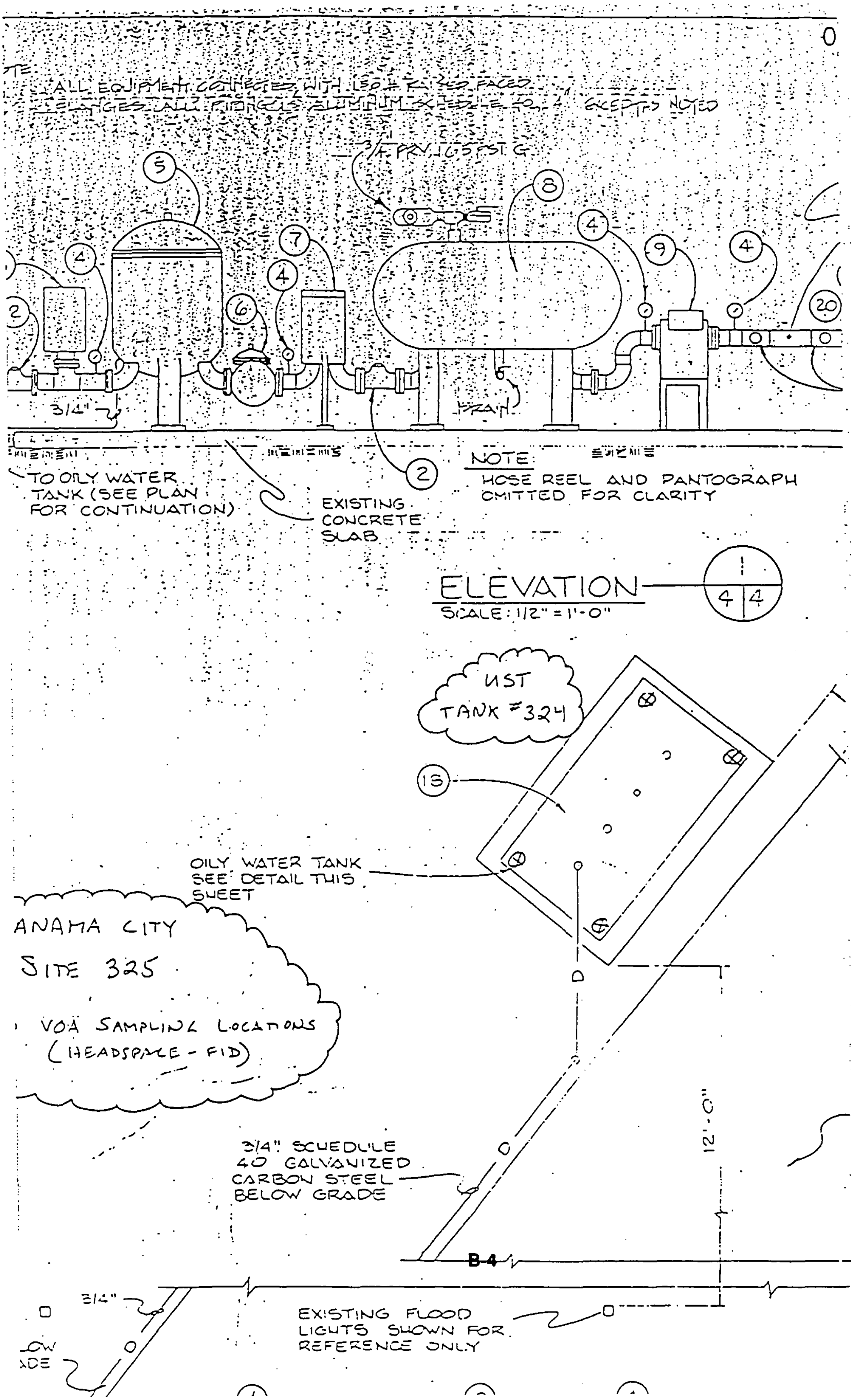
OILY WATER TANK DETAIL

N.T.S. TANK # 324

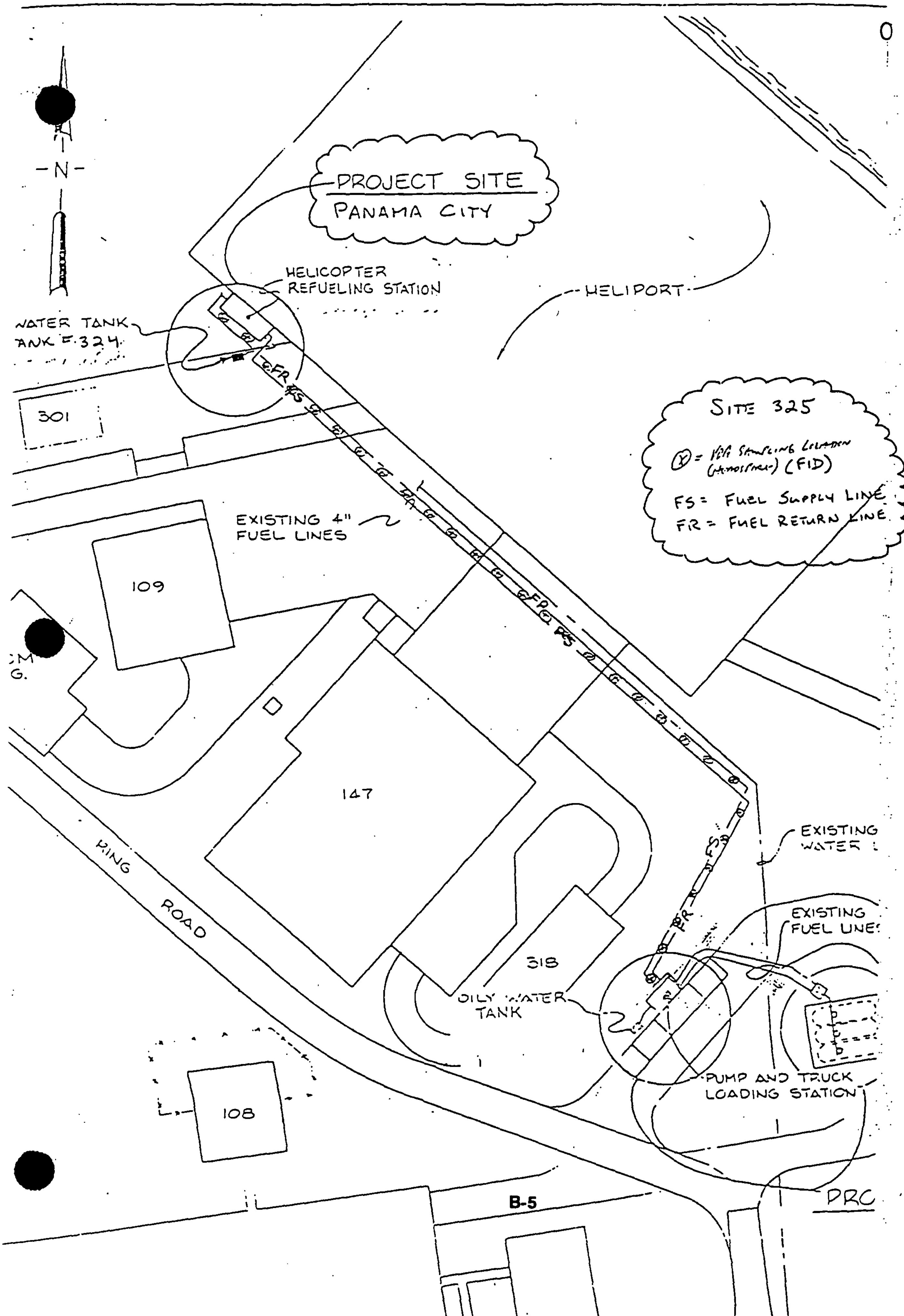
0069963

3

006963



ALL EQUIPMENT CONNECTED WITH 150# RAISED FACED FLANGES ALL PIPING IS ALUMINUM SCHEDULE 40 EXCEPT AS NOTED
3/4" PRV 165 PSIG
3/4"
DRAIN
TO OILY WATER TANK (SEE PLAN FOR CONTINUATION)
EXISTING CONCRETE SLAB
NOTE:
HOSE REEL AND PANTOGRAPH OMITTED FOR CLARITY
ELEVATION
SCALE: 1/2" = 1'-0"
UST TANK #324
OILY WATER TANK SEE DETAIL THIS SHEET
ANAMA CITY
SITE 325
VOA SAMPLING LOCATIONS (HEADSPACE - FID)
3/4" SCHEDULE 40 GALVANIZED CARBON STEEL BELOW GRADE
12'-0"
B-4
3/4"
EXISTING FLOOD LIGHTS SHOWN FOR REFERENCE ONLY


N
PROJECT SITE
PANAMA CITY
HELICOPTER
REFUELING STATION
HELIPORT
WATER TANK
TANK F.324
301
SITE 325
(FID)
FS = FUEL SUPPLY LINE
FR = FUEL RETURN LINE
EXISTING 4"
FUEL LINES
FR
FS
109
147
KING ROAD
318
OILY WATER
TANK
EXISTING
WATER
EXISTING
FUEL LINES
PUMP AND TRUCK
LOADING STATION
108
PRC

Florida Department of Environmental Regulation
Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, Florida 32399-2400

DER Form #:	[illegible]
Form Title:	Closure Assessment Form
Effective Date:	December 10, 1990
DER Application No.	(Filled in by DER)

Closure Assessment Form

ers of storage tank systems that are replacing, removing or closing in place storage tanks shall use this form to demonstrate that a storage m closure assesment was performed in accordance with Rule 17-761 or 17-762, Florida Administrative Code. Eligible Early Detection Incen- EDI) and Reimbursement Program sites do not have to perform a closure assessment.

Please Print or Type
Complete All Applicable Blanks

Date: ______

DER Facility ID Number: 038518667 3. County: Bay

Facility Name: Coastal Systems Station, Panama City

Facility Owner: U. S. Navy

Facility Address: 6703 W. Hwy 98 Code 0511 MC

Mailing Address: Panama City, FL 32407-7001

Telephone Number: (904) 235-5859 9. Facility Operator: Mike Clayton

e Storage Tank(s): (Circle one or both) A. Aboveground or (B. Underground)

Type of Product(s) Stored: Water/ JP-5 from Fuel Filter System

Were the Tank(s): (Circle one) A. Replaced (B. Removed) C. Closed in Place D. Upgraded (aboveground tanks only)

Number of Tanks Closed: One 14. Age of Tanks: 11 years

Facility Assessment Information

No	Not Applicable	
[x]		1. Is the facility participating in the Florida Petroleum Liability Insurance and Restoration Program (FPLIRP)?
[x]		2. Was a Discharge Reporting Form submitted to the Department? If yes, When: ______ Where: ______
[ ]		3. Is the depth to ground water less than 20 feet?
[x]	[ ]	4. Are monitoring wells present around the storage system? If yes, specify type: [ ] Water monitoring [ ] Vapor monitoring
[ ]	[x]	5. Is there free product present in the monitoring wells or within the excavation?
[ ]	[x]	6. Were the petroleum hydrocarbon vapor levels in the soils greater than 500 parts per million for gasoline? Specify sample type: [ ] Vapor Monitoring wells [ ] Soil sample(s)
[ ]	[x]	7. Were the petroleum hydrocarbon vapor levels in the soils greater than 50 parts per million for diesel/kerosene? Specify sample type: [ ] Vapor Monitoring wells [ ] Soil sample(s)
	[x]	8. Were the analytical laboratory results of the ground water sample(s) greater than the allowable state target levels? (See target levels on reverse side of this form and supply laboratory data sheets)
[x]	[ ]	9. If a used oil storage system, did a visual inspection detect any discolored soil indicating a release?
[ ]		10. Are any potable wells located within ¼ of a mile radius of the facility? No longer in service.
[ ]		11. Is there a surface water body within ¼ mile radius of the site? If yes, indicate distance: 100 ft

DER Form # 17-761.900(3)
Form Title Closure Assessment Form
Effective Date December 10, 1990
DER Application No. ______
(Filled in by DER)

A detailed drawing or sketch of the facility that includes the storage system location, monitoring wells, buildings, storm drains, sample locations, and dispenser locations must accompany this form.

If a facility has a pollutant storage tank system that has both gasoline and kerosene/diesel stored on site, both EPA Method 602 and EPA Method 610 must be performed on the ground water samples obtained.

Amount of soils removed and receipt of proper disposal.

If yes is answered to any one of questions 5-9, a Discharge Reporting Form 17-761.900(1) indicating a suspected release shall be submitted to the Department within one working day.

A copy of this form and any attachments must be submitted to the Department's district office in your area and to the locally administered program office under contract with the Department within 60 days of completion of tank removal or filling a tank with an inert material.

______________________ Signature of Owner | ______ Date

Thomas M. Conrad
Signature of Person Performing Assessment | 9/18/95 Date

Technical Lead
Title of Person Performing Assessment

State Ground Water Target Levels That Affect A Pollutant Storage Tank System Closure Assessment

State ground water target levels are as follows:

1. For gasoline (EPA Method 602):
   a. Benzene — 1 ug/l
   b. Total VOA — 50 ug/l
      - Benzene
      - Toluene
      - Total Xylenes
      - Ethylbenzene
   c. Methyl Test-Butyl Ether (MTBE) — 50 ug/l

2. For kerosene/diesel (EPA Method 610):
   a. Polynuclear Aromatic Hydrocarbons (PAHS) (Best achievable detection limit, 10 ug/l maximum)

APPENDIX C

BASIS OF DESIGN

APPENDIX C-I

BASIS OF DESIGN

Appendix C-I

BASIS OF DESIGN

The purpose of this Remedial Action Plan (RAP) is to present a plan for remediation of petroleum contamination at the Facility 325, CSS Panama City, Panama City, Florida, in accordance with the requirements of Chapter 62-770, Florida Administrative Code (FAC). Implementation of the RAP will include the following tasks:

- vacuum enhanced extraction of free product, and limited extraction of groundwater, treatment of mixed fluids at the oily waste collection and treatment system;
- vacuum enhanced extraction of soil vapor, and treatment of soil vapor;
- installation of necessary piping for a future potential aquifer air sparging system; and
- groundwater monitoring.

Based on the field data and laboratory analytical results, as presented in the Contamination Assessment Report (CAR) and CAR Addendum, site conditions are as follows.

Groundwater depths range approximately from 5 to 7 feet below land surface (bls). Groundwater flow direction near the site is generally to the east towards the St Andrew Bay. The calculated average hydraulic gradient in the surficial aquifer is 8.74×10^{-3} feet per foot (ft/ft). Slug test results indicate an average horizontal hydraulic conductivity (K) of 21.1 ft/day. The calculated pore water velocity (v) is 0.74 ft/day.

CSS Panama City is underlain by three water bearing zones. These zones include the water-table aquifer, the secondary artesian aquifer, and the Floridan aquifer system. The water table aquifer is comprised of highly permeable quartz sands with scattered lenses of clayey sands and sandy clays. It ranges in thickness from 65 to 145 feet. The Floridan aquifer system is separated from the overlying aquifers by semi-confining beds within the Intracoastal Formation. It is hydraulically connected with the overlying strata in this area. It has been estimated that the thickness of the potable zone of the Floridan aquifer ranges between 250 feet and 1,000 feet in Bay County (Causey, and Leve, 1976).

Contamination associated with the free product is reported as confined to small pockets and would be dealt with through a monitoring and recovery program. The estimated volume of free product based on free product thickness observations on April 27, 1996 is about 500 gallons.

Contamination associated with the soil is confined between 2 ft bls to 6 ft bls (location of the water table) and has an estimated volume of 3000 cubic yards. Technologies selected for soil treatment should allow implementation of free product monitoring and recovery program.

Contaminants associated with groundwater are confined within about 25 feet below the groundwater table (based on the groundwater quality at the deepest monitoring well MW-16D). Contaminants including TVOA, total naphthtalenes and TRPH are anticipated to be naturally attenuated.

Soil vapor extraction and free product recovery and limited groundwater extraction will be implemented simultaneously using a liquid ring pump via vacuum enhanced extraction. The total fluids including free product and groundwater will be discharged in the oily waste collection and treatment system located on base. The hydrocarbon vapors will be treated by using Granular Activated Carbon filters installed on site. Once the free product monitoring and recovery program indicates absence of free product, and SVE vapor concentrations reach asymptotic levels, installation of aquifer air sparging wells will be evaluated.

The evaluation may lead to one of two decisions:

- If the evaluation indicates that installing an AAS system is economical for reducing TVOA concentrations in groundwater, the AAS wells will be installed and hooked up to a compressor of the designed size. The AAS system installation will be completed within 4 weeks after approval of the decision. Time of cleanup of soil and groundwater (if required) is estimated as two years.

- If the evaluation indicates that the groundwater TVOA concentrations may be attenuated through natural processes of degradation then the installation of an AAS system is not warranted. Time of cleanup of soil and groundwater (if required) will be less than two years.

The system will be monitored weekly for the first month, monthly for the remainder of the first year, and quarterly rest of the operation years. Groundwater is proposed to be monitored only for the indicator chemicals of concern (including BTEX, and total naphthalenes). Once soil cleanup is completed (verified based on persistence of the asymptotic levels of vapor concentrations), groundwater will be monitored quarterly for one year and the site will be proposed for a "No Further Action".

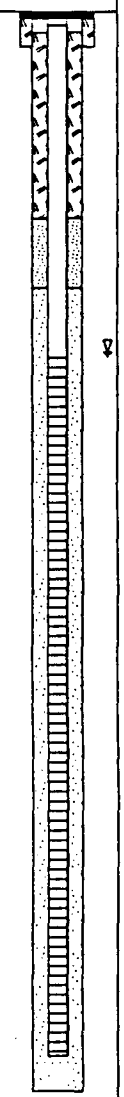
APPENDIX C-II

SOIL BORING LOGS

Appendix C-II
Soil Boring Logs

TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-5	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/28/92	COMPLTD: 09/28/92
METHOD: 4.25" I.D. HSA	CASE SIZE: 2"	SCREEN INT.: 5-15
PROTECTION LEVEL: D	TOC ELEV.: 7.90 FT.	MONITOR INST.: OVA
TOT DPTH: 15FT.	DPTH TO ∇ 4.92 FT.	
LOGGED BY: P. Wagner	WELL DEVELOPMENT DATE: 09/28/92	SITE: 325

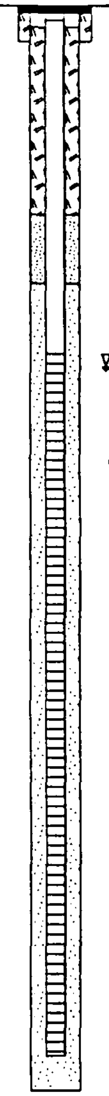
DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
			posthole	0	SAND: Grayish orange pink, medium-grained, moderately sorted.		SP		
			posthole	0	SAND: Mottled dark gray and medium light gray, very fine- to fine- grained, moderately sorted.				
5			1.3/2	0	SAND: Grayish orange to medium light gray, fine- to medium-grained, poorly sorted, 1-inch clay lense, damp.				
			1.9/2	G.C.	SAND: Pale yellowish brown, medium-grained, well sorted, saturated.				
			2.0/2	G.C.	As above.				
10									
15									
20									



TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-6	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/28/92	COMPLTD: 09/28/92
METHOD: 4.25" I.D. HSA	CASE SIZE: 2" / SCREEN INT.: 5-15	PROTECTION LEVEL: D
TOC ELEV.: 7.63 FT.	MONITOR INST.: OVA / TOT DPTH: 15FT.	DPTH TO ▽ 5.19 FT.
LOGGED BY: P. Wagner	WELL DEVELOPMENT DATE: 09/28/92	SITE: 325

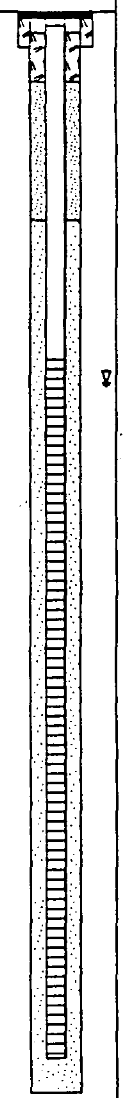
DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN
			posthole	0	SAND: Very pale orange, medium-grained, moderately sorted.		SP	
			posthole	0	SAND: Grayish orange pink, medium-grained, moderately sorted.			
5			1.8/2	0	SAND: Grayish orange pink, medium-grained, well sorted.			
			1.7/2	49	SAND: Grayish orange, medium-grained, moderately sorted, damp, slight petroleum odor.			
			2.0/2	G.C.	SAND: brownish gray, medium-grained, well sorted, wet, petroleum odor.			
10								
15								
20								

WELL DATA



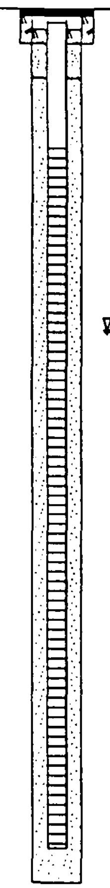
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-7	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/29/92	COMPLTD: 09/29/92
METHOD: 4.25" I.D. HSA	CASE SIZE: 2" / SCREEN INT.: 5-15	PROTECTION LEVEL: D
TOC ELEV.: 7.54 FT.	MONITOR INST.: OVA / TOT DPTH: 15FT.	DPTH TO ▽ 5.34 FT.
LOGGED BY: P. Wagner	WELL DEVELOPMENT DATE: 09/29/92	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
			posthole	0	SAND: Very pale orange, medium-grained, well sorted.		SP		
			posthole	0	As above.				
5			1.5/2	0	As above.				
			1.7/2	0	As above.				
			2.0/2	30	SAND: Brownish gray, medium-grained, well sorted, wet, slight petroleum odor.				
10									
15									
20									



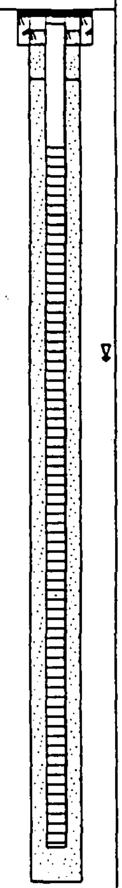
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-8	BORING NO. SB-2
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 07/28/94	COMPLTD: 07/28/94
METHOD: 10" O.D. HSA	CASE SIZE: 4" / SCREEN INT.: 2-12	PROTECTION LEVEL: D
TOC ELEV.: 9.78 FT.	MONITOR INST.: OVA / TOT DPTH: 12FT.	DPTH TO ▽ 4.60 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 07/28/94	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
							SP		
				200	SAND: Light gray, medium gray, brown, fine- to medium-grained.				
5									
				3,100	As above.				
10									
15									
20									



TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-9	BORING NO. SB-7
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 07/29/94	COMPLTD: 07/29/94
METHOD: 10" O.D. HSA	CASE SIZE: 4" / SCREEN INT.: 2-12	PROTECTION LEVEL: D
TOC ELEV.: 9.77 FT.	MONITOR INST.: OVA / TOT DPTH: 12FT.	DPTH TO ▽ 4.99 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 07/29/94	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5				0	SAND: Medium brown to light gray, fine- to medium-grianed.				
				2,400	SAND: Light gray to dark gray, fine- to medium-grained with gravel.				
10									
15									
20									



TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-10	BORING NO. SB-8
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 07/30/94	COMPLTD: 07/30/94
METHOD: 10" O.D. HSA / CASE SIZE: 4"	SCREEN INT.: 2-12	PROTECTION LEVEL: D
TOC ELEV.: 10.03 FT. / MONITOR INST.: OVA	TOT DPTH: 12FT.	DPTH TO ∇ 5.46 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 07/30/94		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
4				0	SAND: Light gray, red, black, fine- to medium-grained, some clay (10%).				
5									∇
6				900	SAND: As above, petroleum odor.				
10									
15									
20									

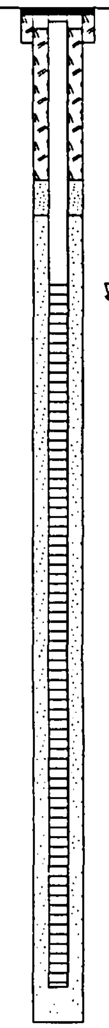
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-11	BORING NO. SB-17
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/26/95	COMPLTD: 09/26/95
METHOD: 4.25" I.D. HSA; CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 9.52 FT.; MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ∇ 4.40 FT.
LOGGED BY: J. Koch; WELL DEVELOPMENT DATE: 09/26/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
							SP		
				0	SAND: Light brown to medium gray, fine- to medium-grained, some clay (10%)				
				0	As above				
5									
				0	As above				
10									
15									
20									

TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-12	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/26/95	COMPLTD: 09/26/95

METHOD: 4.25" I.D. HSA	CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 9.12 FT.	MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 4.15 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 09/26/95		SITE: 325

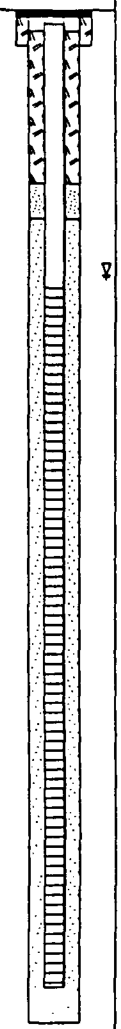
DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0–6					SAND FILL		SP		
6–14					GRAVEL FILL: 1- to 1.5-inch diameter stones, light gray to medium gray, some sand		GP		
5, 10, 15, 20									



TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-13	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/27/95	COMPLTD: 09/27/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 8.92 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ∇ 3.82 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 09/27/95	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0–14					SAND: Light brown to light gray, fine- to medium-grained, well sorted		SP		

Depth scale: 5, 10, 15, 20



TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-14	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/27/95	COMPLTD: 09/27/95
METHOD: 4.25" I.D. HSA	CASE SIZE: 2" / SCREEN INT.: 2-12	PROTECTION LEVEL: D
TOC ELEV.: 6.84 FT.	MONITOR INST.: OVA / TOT DPTH: 12FT.	DPTH TO ▽ 2.89 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 09/27/95	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0–13				GC	SAND: Light brown to light gray, fine- to medium-grained, well sorted		SP		
5									
10									
15									
20									

TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-15	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/27/95	COMPLTD: 09/27/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 9.56 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 4.75 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 09/27/95	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5									
					SAND: Light brown to light gray, fine- to medium-grained, well sorted				
10				230					
15									
20									

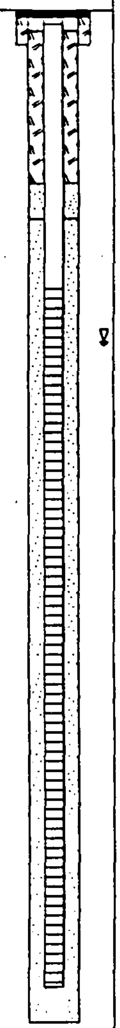


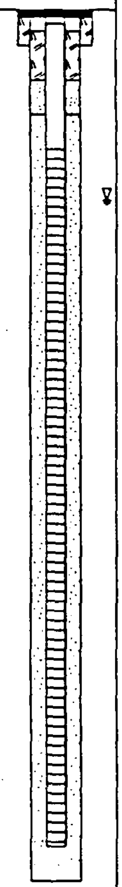
 ABB ENVIRONMENTAL SERVICES, INC.

TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-16D	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/28/95	COMPLTD: 10/01/95
METHOD: HSA, Mud Rotary	CASE SIZE: 2"; 6" / SCREEN INT.: 25-30	PROTECTION LEVEL: D
TOC ELEV.: 9.56 FT.	MONITOR INST.: OVA / TOT DPTH: 30FT.	DPTH TO ∇ 4.85 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 10/16/95	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
5					SAND FILL		SP		
				1,100	GRAVEL: 1- to 1.5-inch diameter stones, light gray to medium gray, some sand, petroleum odor.		GP		
10				1,400	As above.				
				1,000	As above, with fiberglass remains of the underground storage tanks				
15				500	As above.				
				1,100	SAND: Light gray to medium gray, fine- to coarse-grained, slight petroleum odor.		SP		
				450	As above.				
20				80	SAND: Light gray, fine- to coarse-grained, no odor.				
25				1	SAND: Medium gray, fine- to coarse-grained, no odor.				
				5	As above.				
30				1	CLAYEY SAND: Medium gray, fine- to coarse-grained, no odor.		SC		
35									
40									

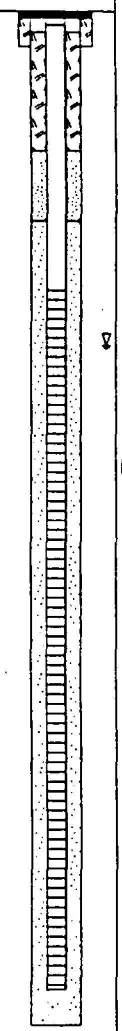
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-17	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/28/95	COMPLTD: 09/28/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 2-12	PROTECTION LEVEL: D
TOC ELEV.: 6.86 FT. / MONITOR INST.: OVA	TOT DPTH: 12FT.	DPTH TO ▽ 2.74 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/28/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5									
6				GC	SAND: Light brown to light gray, fine- to medium-grained, well sorted				
10									
15									
20									



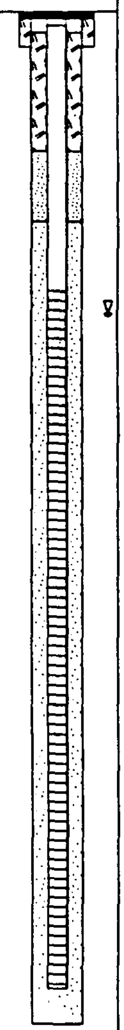
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-18	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/28/95	COMPLTD: 09/28/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 9.68 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 4.79 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/28/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5									▽
				GC	SAND: Light brown to light gray, fine- to medium-grained, well sorted				
10									
15									
20									



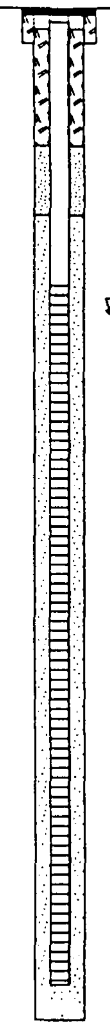
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-19	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/29/95	COMPLTD: 09/29/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 10.10 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 4.32 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/29/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5									
6				GC					
7					SAND: Light brown to light gray, fine- to medium-grained, well sorted				
10									
15									
20									



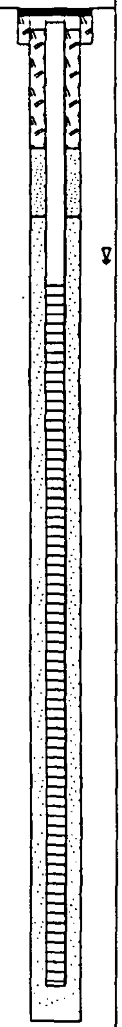
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-20	BORING NO. SB-29
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/29/95	COMPLTD: 09/29/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 10.24 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ∇ 4.36 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/29/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					SAND: Light brown to white, fine- to medium-grained.		SP		
					CLAYEY SAND: Brown, gray, black, fine- to medium-grained, 40% clay.		SC		
5					As above.				
				GC					
							SP		
10									
15									
20									



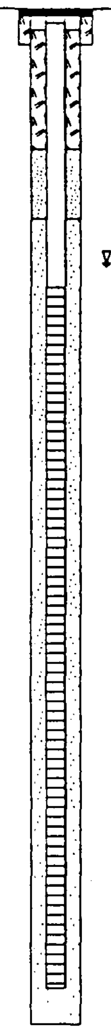
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-21	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/29/95	COMPLTD: 09/29/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 9.42 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 3.64 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/29/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
					SAND FILL		SP		
5									
10					SAND: Light brown to light gray, fine- to medium-grained, well sorted		SP		
15									
20									



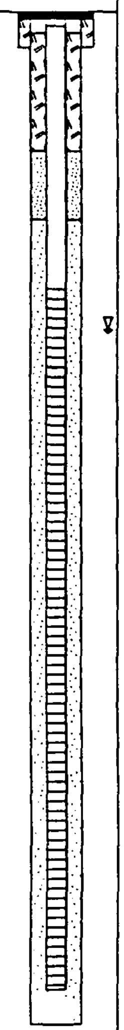
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-22	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/29/95	COMPLTD: 09/29/95
METHOD: 4.25" I.D. HSA — CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 9.53 FT. — MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 3.64 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 09/29/95	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0–14				GC	SAND: Light brown to light gray, fine- to medium-grained, well sorted		SP		
5									
10									
15									
20									

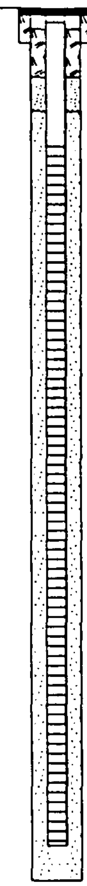


TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-23	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/29/95	COMPLTD: 09/29/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 9.88 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 4.57 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/29/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
3					SAND FILL				
5				GC					
6							SP		
10					SAND: Light brown to light gray, fine- to medium-grained, well sorted				
15									
20									

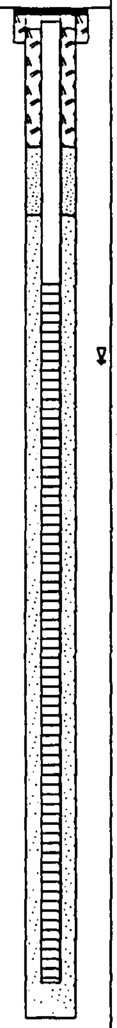


TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-24		BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM			PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.		DATE STARTED: 09/30/95	COMPLTD: 09/30/95
METHOD: 4.25" I.D. HSA	CASE SIZE: 2"	SCREEN INT.: 2-12	PROTECTION LEVEL: D
TOC ELEV.: 8.80 FT.	MONITOR INST.: OVA	TOT DPTH: 12FT.	DPTH TO ▽ 5.02 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 09/30/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0–12					SAND: Light brown to light gray, fine- to medium-grained, well sorted		SP		
5									▽
10									
15									
20									

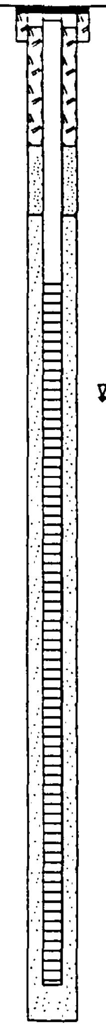
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-25	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/30/95	COMPLTD: 09/30/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 10.73 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ∇ 5.10 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/30/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0–14				GC	SAND: Light brown to light gray, fine- to medium-grained, well sorted		SP		
5									
10									
15									
20									



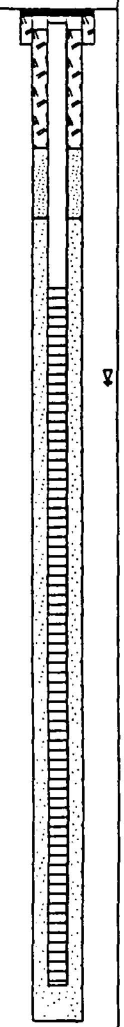
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-26	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/30/95	COMPLTD: 09/30/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 10.81 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 5.62 FT.
LOGGED BY: J. Koch / WELL DEVELOPMENT DATE: 09/30/95		SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5					SAND: Light brown, fine- to medium-grained, well sorted				▽
				GC					
10									
15									
20									



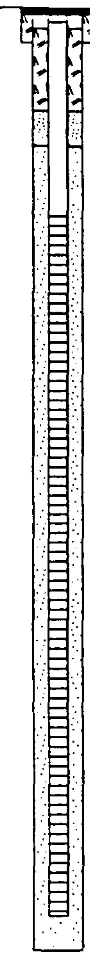
TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-27	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 09/30/95	COMPLTD: 09/30/95
METHOD: 4.25" I.D. HSA / CASE SIZE: 2"	SCREEN INT.: 4-14	PROTECTION LEVEL: D
TOC ELEV.: 10.44 FT. / MONITOR INST.: OVA	TOT DPTH: 14FT.	DPTH TO ▽ 5.35 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 09/30/95	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5									▽
				GC					
					SAND: Light brown, fine- to medium-grained, well sorted				
10									
15									
20									



TITLE: CSS PANAMA CITY	LOG of WELL: CSS-325-28	BORING NO. N/A
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: 7520.31
CONTRACTOR: Groundwater Protection, Inc.	DATE STARTED: 10/01/95	COMPLTD: 10/01/95
METHOD: 4.25" I.D. HSA	CASE SIZE: 2" / SCREEN INT.: 3-13	PROTECTION LEVEL: D
TOC ELEV.: 9.88 FT.	MONITOR INST.: OVA / TOT DPTH: 13FT.	DPTH TO ▽ 5.24 FT.
LOGGED BY: J. Koch	WELL DEVELOPMENT DATE: 10/01/95	SITE: 325

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0							SP		
5									▽
6				GC	SAND: Light brown, fine- to medium-grained, well sorted				
10									
15									
20									



APPENDIX D

DESIGN CALCULATIONS

Appendix D-I	SVE Vacuum Pump Sizing
Appendix D-II	Soil Cleanup Time Estimate
Appendix D-III	AAS Compressor Sizing
Appendix D-IV	AAS Cleanup Time
Appendix D-V	Total Fluids Cleanup
Appendix D-VI	Vapor Treatment System

APPENDIX D-I

SVE VACUUM PUMP SIZING

Appendix D–I

Soil Vapor Extraction – Vacuum Pump Sizing
Remedial Action Plan
Coastal Systems Station, Facility 325, Panama City
Panama City, Florida

Engineer:	KGK	Date:	05/16/96	Checked By:

a. Flow Rate

A	Plan View Area of Soil with OVA readings >10 ppm	21111.11 ft^2	Figure. 3–2
H	Vertical extent of excessively contaminated soil	4.00 ft	Table 3–1
V	Bulk Volume	84444.44 ft^3	
n	porosity	0.25	assumed
v	Pore Volume	21111.11 ft^3	
Q	air flow rate required to maitnatin 1 pore volume per day	14.66 cfm	

b. Maximum Possible Flow Rate

			k1	k2		
k	intrinsic permeability of soil		1.00E–08	1.00E–07	cm^2	slug tests
u	viscosity of air		1.80E–04	1.80E–04	g/cm–s	constant
P w	absolute pressure at extraction well		8.00E+05	8.00E+05	g/cm–s^2	assumed
P Atm	absolute ambient pressure		1.01E+06	1.01E+06	g/cm–s^2	constant
R w	radius of vapor extraction well		5.12	5.12	cm	constant
R i	radius of influence of vapor extraction well		35.00	35.00	ft	assumed
	conversion	[ft/cm = 30.72]	1075.20	1075.20	cm	
Q/H	flow rate per unit thickness		15.51	155.15	cm^3/s	calculated
H	thickness of zone of soil contamination		122.88	122.88	cm	Table 3–1
Q	flow rate		1906.44	19064.36	cm^3/s	calculated
	conversion	[(cm^3/s)/cfm = 0.0021]	4.0395267	40.395267	cfm	

Use a flow rate that is maximum of

Qa	Based on an air flow of one pore volume per day	14.66 cfm
Qb1	Based on an intrinsic permeability of 1 Darcy (k1)	4.04 cfm
Qb2	Based on an intrinsic permeability of 10 Darcys (k2)	40.4 cfm

Hence practical range of flow rate is 4.04 cfm to 40.4 cfm
Use the maximum cfm for the purposes of selection of a pump. 45 cfm

Number SVE Points

A	plan view area	21111.111 ft^2	
Ri	radius of influence	35 ft	assumed
N	number of SVE points	5.48	
	Use 5 SVE points		
Q t	total flow rate	225 cfm	

Vacuum Pump Selection

Required flow rate 225 cfm

Use One Model A300 Fluid–Vac liquid ring vacuum pump close coupled to a 20 HP, 230/460/3/60 explosion proof motor. 300 acfm, 0–22 inches Hg vacuum

atlantic fluidics, inc.

21 South Street, South Norwalk, CT 06854
(203) 853-7315, Fax: (203) 866-8218

April 24, 1996

Date:
Reference:

Mr. Gopi Kanchibhatli
ABB Environmental Services
2591 Executive Ctr Circle East
Tallahassee, FL 32301 FAX# 904 877-0742

Dear Gopi,

We are pleased to offer our proposal as follows:

One Model A200 Fluid-Vac® dual extraction soil venting package consisting of Model A200 Fluid-Vac liquid ring vacuum pump in cast iron construction, close coupled to 15 HP, 1160 RPM, 208-230/460/3/60 explosion proof motor, including 120 gallon stainless steel seal reservoir tank with flanged cleanout access, seal water flow control, Y-strainer, make up valve, external float switch in full length sight tube, and inlet strainer, completely piped and mounted on steel baseplate.

Price: $9,326.00

1. Electrical controller, including on-off push button, motor starter, overload protection and control transformer in NEMA 7 enclosure completely piped and wired and mounted on stainless steel tank.

Price addition: $2,866.00

2. Dual phase extraction, including transfer pump activated by liquid level switches close coupled to 3/4 HP, 3450 RPM, 208-230/460/3/60 explosion proof motor, rated 30 GPM at 50 ft head, fully piped and wired on an extended baseplate.

Price addition: $1,644.00

3. Air cooled heat exchanger driven by 3 HP, 1140 RPM, 208-230/460/3/60 explosion proof mtor, fully piped and mounted on an extended baseplate.

Price addition: $3,031.00

4. Demisting pad mounted in flanged assembly on stainless steel tank for removal of up to 99% of entrained liquid in discharged vapor.

Price addition: $646.00

Shipment: 5-6 weeks from date of order, FOB Norwalk, CT

Terms: Net 30 (subject to credit approval)

Please let me know if you need any further assistance.

Very truly yours,

Karim Khidhayir
Italy

TERMS: NET 30 DAYS

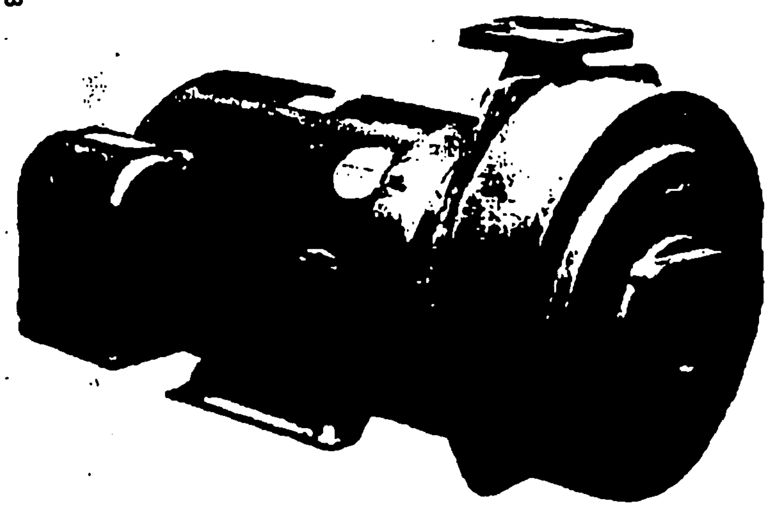
SEE REVERSE SIDE FOR TERMS AND CONDITIONS

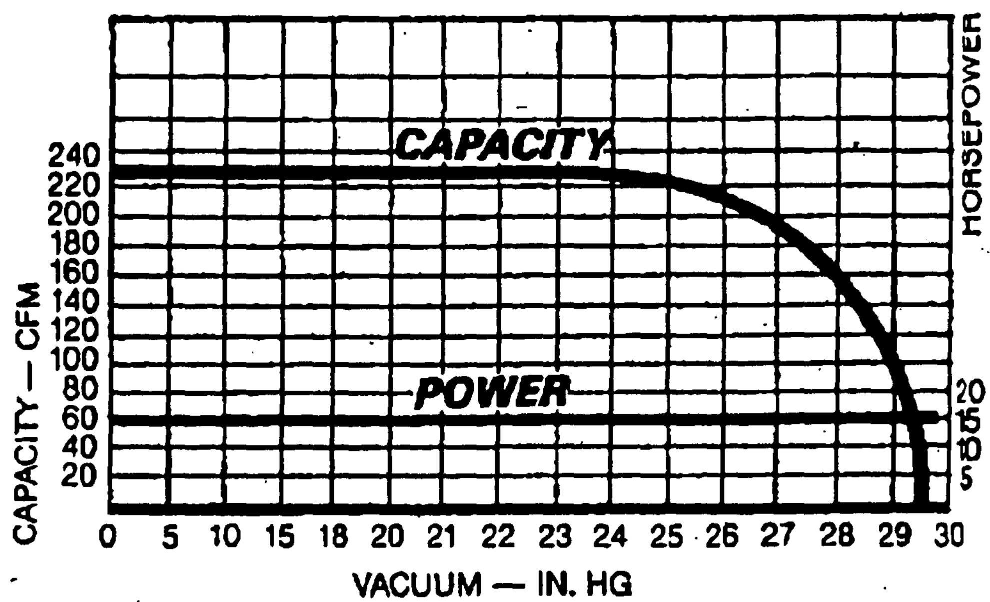
MODEL A200
Liquid Ring Vacuum Pump

D-3

Features:

- ***Axial flow design provides highest vacuum of any single stage liquid ring vacuum pump.***
- ***Power requirements are constant over full vacuum range.***
- ***Outstanding liquid handling capacity.***
- ***Compact close coupled design.***
- ***100% American.***





WATER CONSUMPTION

0.10" Hg.—6 GPM
10-25" Hg.—8 GPM
Over 25" Hg.—10 GPM

NOTES:

Performance corrected for 60°F seal water and 30 in. Hg barometer.

features:

Rugged Simplified Construction — all components are designed for 24 hour per day continuous service under the most demanding industrial conditions.

High vacuum characteristics — Exclusive axial flow design permits efficient operation in the full vacuum range from 0 to 29 inches of mercury (760-25 Torr).

Vibrationless operation — No special foundations required.

Low Maintenance — No metal-to-metal contact between rotating and stationary elements.

Environmentally clean — No oil used for lubrication or sealing. No oil vapor discharge to atmosphere.

Advanced Design — Employs mechanical seal and O Ring gaskets for zero leakage.

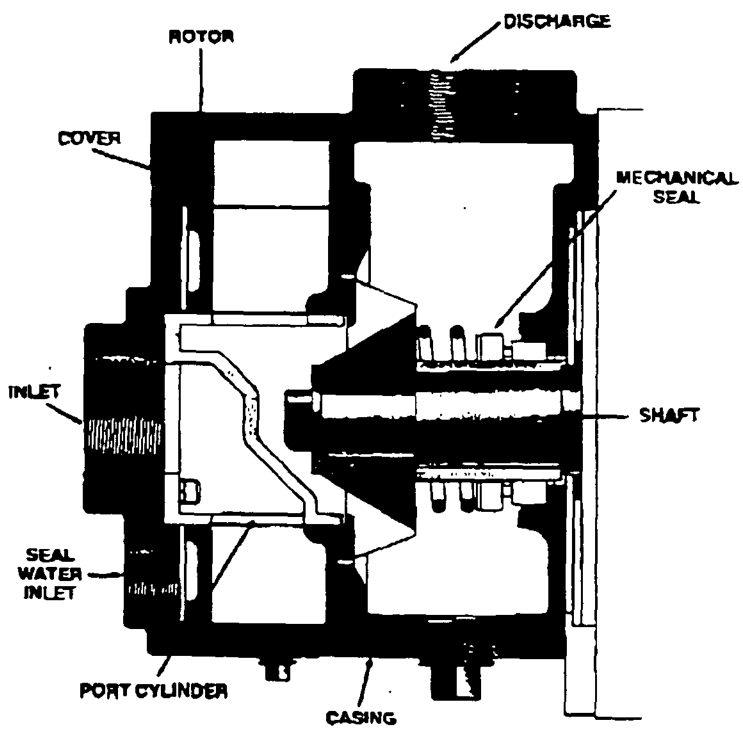
Constant Power — Power requirements are constant over the full vacuum range. Non-overloading.

performance:

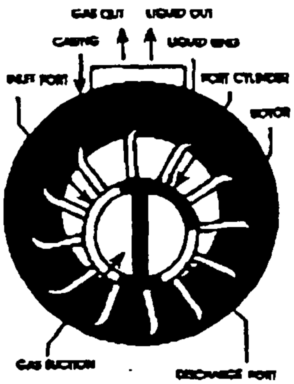
Model	HP	Capacity (CFM) at Vacuum (in Hg.) 5	10	15	20	25	27	28	Weight (lb.) approx.
3550 RPM									
A 10	1½	15	15	15	15	15	13	10	55
A 15	2	22	22	22	22	20	16	13	60
A 20	3	34	34	34	34	32	26	18	80
1750 RPM									
A 75	5	72	72	74	74	72	65	45	180
A 100	7½	100	102	102	102	100	86	60	195
A 130	10	125	125	125	125	118	95	65	250
1125 RPM									
A 200	15	230	230	230	230	220	190	135	560

Dry air performance data curves based on service liquid water at 60°F. Barometric Pressure—Sea Level—29.92" Hg.

construction:



operation:



The Atlantic liquid ring vacuum pump consists of a shrouded rotor rotating freely within an eccentric casing. There is no metal-to-metal contact between the rotor and the casing. Centrifugal force acting on liquid within the pump causes the liquid to form a ring inside the casing. A fixed port cylinder concentric with the rotor directs the gas into the suction ports. Gas is trapped between the blades by the liquid pistons formed by centrifugal force as the liquid recedes from the port cylinder. It is trapped at the point of maximum eccentricity and is then compressed by the liquid ring as it is forced radially inward toward the central port cylinder. After each revolution the compressed gas and accompanying liquid are discharged.

During the pumping cycle the gas is in intimate contact with the sealing liquid and compression is nearly isothermal. When handling saturated vapor-gas mixtures the liquid ring acts as a condenser, greatly increasing the effective capacity of the pump.

The Fluid-Vac pump is not just another liquid ring vacuum pump

All Fluid-Vac systems are designed around liquid ring vacuum pumps engineered and manufactured by Atlantic Fluidics. Because of an advanced axial flow design our liquid ring vacuum pumps are the only pumps that can start flooded, handle up to 30 gpm of water, and use contaminated ground water as a seal fluid and still give a constant air flow and an ultimate vacuum of 29" Hg.

Fluid-Vac soil remediation systems are entirely engineered and manufactured by Atlantic Fluidics specifically for remediation applications. The high vacuum capabilities of the Fluid-Vac system enhance the removal of both vapor and liquid phase contaminants from the ground with a single piece of equipment.

Atlantic Fluidics has been supplying liquid ring vacuum pumps for remediation applications since 1979. We developed the Fluid-Vac system in 1988 to overcome the problems of engineering and assembling a liquid ring pumping system on site. Our years of experience in this industry have enabled us to overcome all of the obstacles usually associated with the application and use of this technology for remediation.

The Fluid-Vac system comes factory tested and ready for field installation.

Standard equipment

- Fluid-Vac pump and motor (TEFC or explosion proof)
- Stainless steel reservoir/separator tank
- Low level switch
- Flow control valve
- Sight glass
- Inlet strainer
- Isolation valve
- Vacuum gauge
- Pressure gauge
- Completely piped, wired, and mounted on a steel baseplate

Accessories

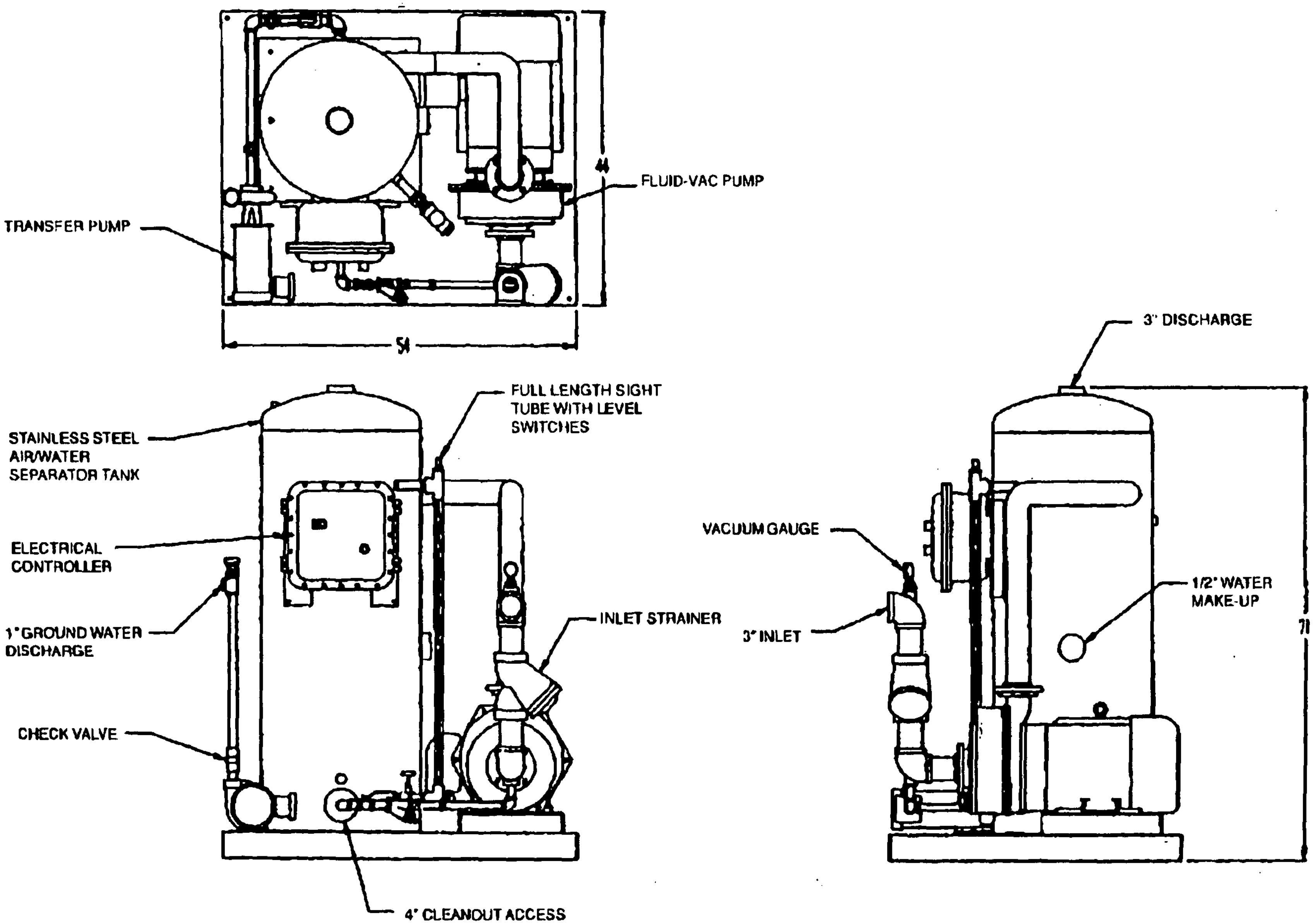
- Electrical controller with NEMA 4 or NEMA 7 panel, overload protection, motor starters, on/off/reset buttons, and transformer completely wired
- Transfer pump and level controls mounted, piped, and wired to electrical controller

Optional equipment

- Mist eliminator – To remove entrained moisture from the air stream
- Air cooled heat exchanger – For locations with high ambient temperature
- Interlock cable for telemetry system – For easy field installation

D-7

A200 SIMPLEX SOIL REMEDIATION PACKAGE SPECIFICATIONS



atlantic fluidics, inc.

atlantic fluidics, inc.

21 South Street, South Norwalk, CT 06854

(203) 853-7315, Fax: (203) 866-8218

May 3, 1996

Date: Mr. Gobi Nchibhala

Reference: ABB Environmental FAX# 904 877-0742

Dear Gobi,

It was a pleasure talking with you this morning. Per our conversation, I am enclosing some information about the seal water temperatures effect on the performance of our liquid ring vacuum pumps. The chart is based on our 5 HP pump rated at 75 CFM.

As well I am enclosing performance curves on our Model A200 and A300 vacuum pumps and dimensional outline drawings of our systems.

The price of these pumps is as follows:

One Model A200 Fluid-Vac® liquid ring vacuum pump in cast iron construction, close coupled to a 15 HP, 230/460/3/60 explosion proof motor.

Price: $5,243.00

One Model A300 Fluid-Vac liquid ring vacuum pump in cast iron construction, close coupled to a 20 HP, 230/460/3/60 explosion proof motor.

Price: $6,332.00

After you have reviewed the information please let me know if you have any other questions. We welcome the opportunity to work with you and your company.

Sincerely,

Robert H. Huse
RHH:ly

TERMS: NET 30 DAYS

SEE REVERSE SIDE FOR TERMS AND CONDITIONS

Capacity is as follows:

Model A75 - 5 HP

Calculated Dry Air Capacity - CFM

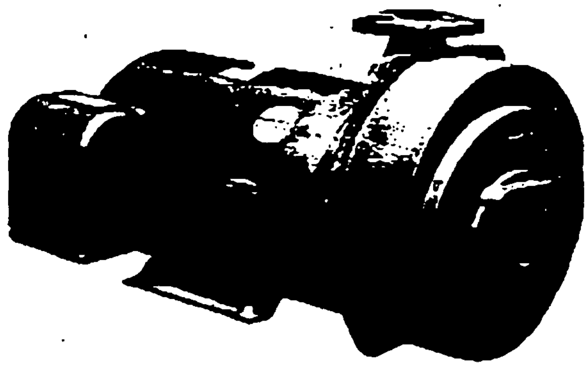
Vacuum in Inches Hg.

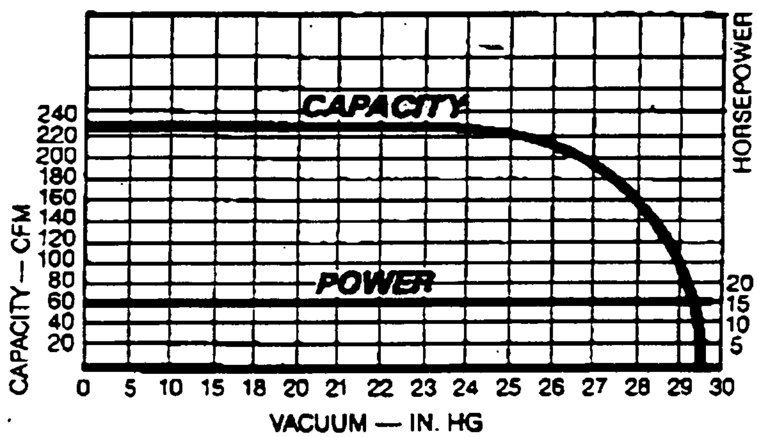
Seal Temp F	20"	25"	26"	27"	28"	28.5"
60	74	74	71	65	45	30
70	73	72	67	59	40	25
80	71	68	63	52	39	19
90	69	62	57	42	27	
100	67	58	49	31		
110	66	49	39			
120	61	31				
130	41					

MODEL A200
Liquid Ring Vacuum Pump

Features:

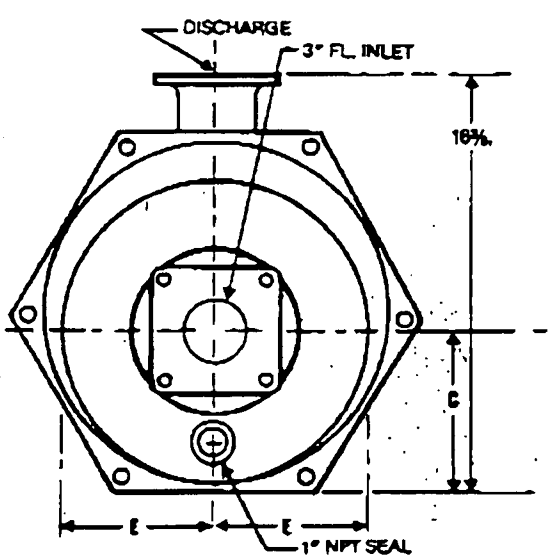
- Axial flow design provides highest vacuum of any single stage liquid ring vacuum pump.
- Power requirements are constant over full vacuum range.
- Outstanding liquid handling capacity.
- Compact close coupled design.
- 100% American.

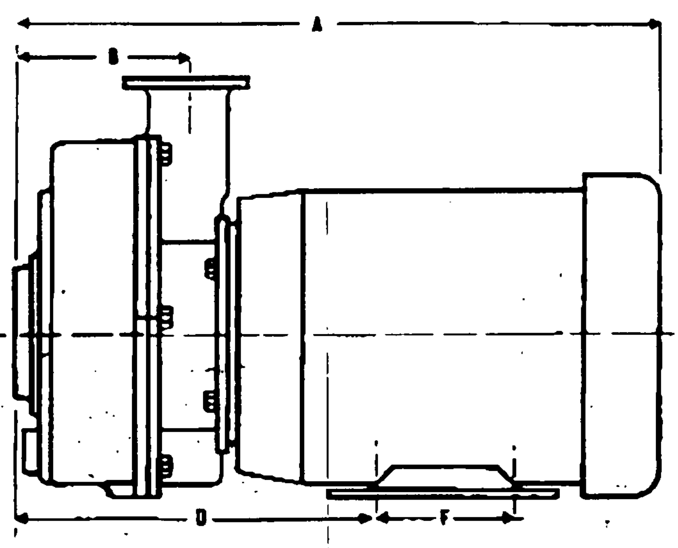




WATER CONSUMPTION
0.10" Hg.—6 GPM
10-25" Hg.—8 GPM
Over 25" Hg.—10 GPM

NOTES:
Performance corrected for 60°F seal water and 30 in. Hg barometer.





Frame	A	B	C	D	E	F	Weight
284	30½	8	7	18⅜	5½	9½	560 lb

atlantic fluidics, Inc.

21 South St, S. Norwalk, CT 06854

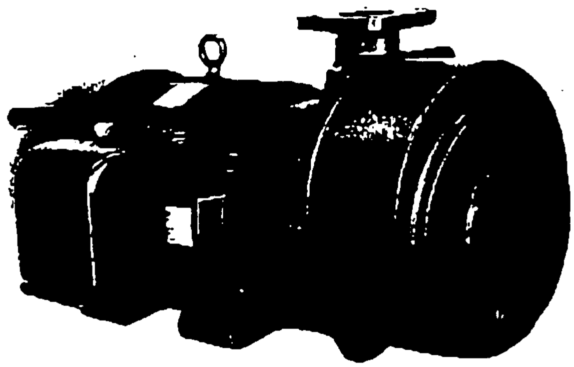
Printed in U.S.A.

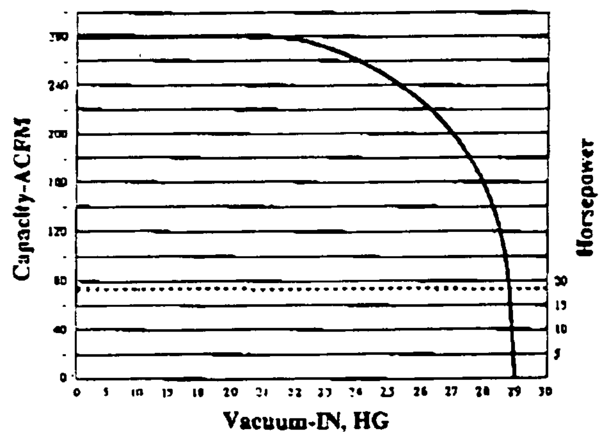
Model A300

Liquid Ring Vacuum Pump

Features:

- ***Axial flow design provides highest vacuum of any single stage liquid ring pump***
- ***Power requirements are constant over full vacuum range***
- ***Outstanding liquid handling capacity***
- ***Compact close coupled design***
- ***100% American***



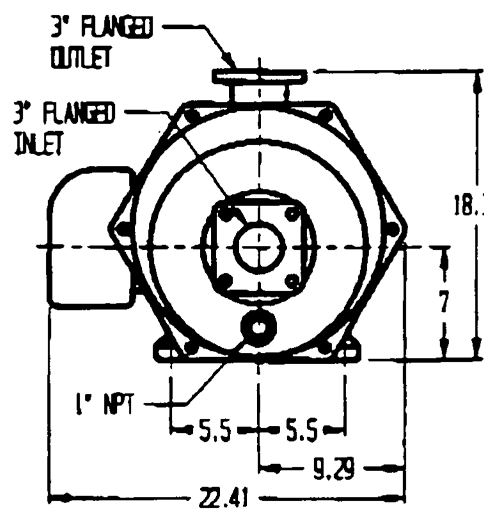


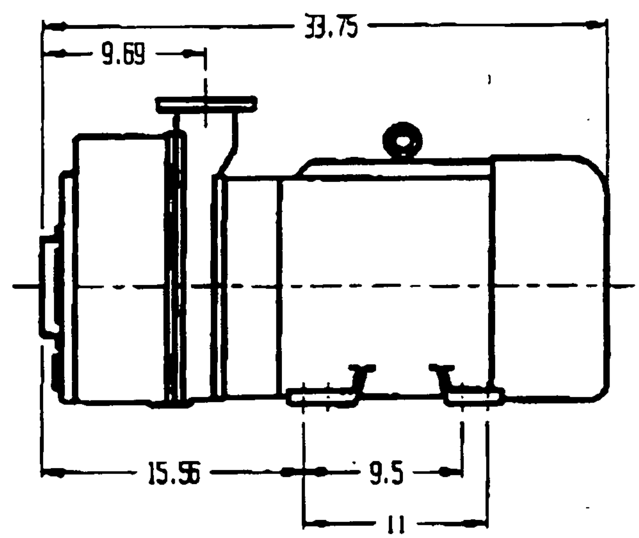
WATER CONSUMPTION

0-10" Hg. – 6 GPM
10-25" Hg. – 8 GPM
Over 25" Hg. – 10 GPM

NOTES:

Performance corrected for 60° F seal water and 30 in. barometer.





atlantic fluidics, inc.
21 South Street, South Norwalk, CT 06854
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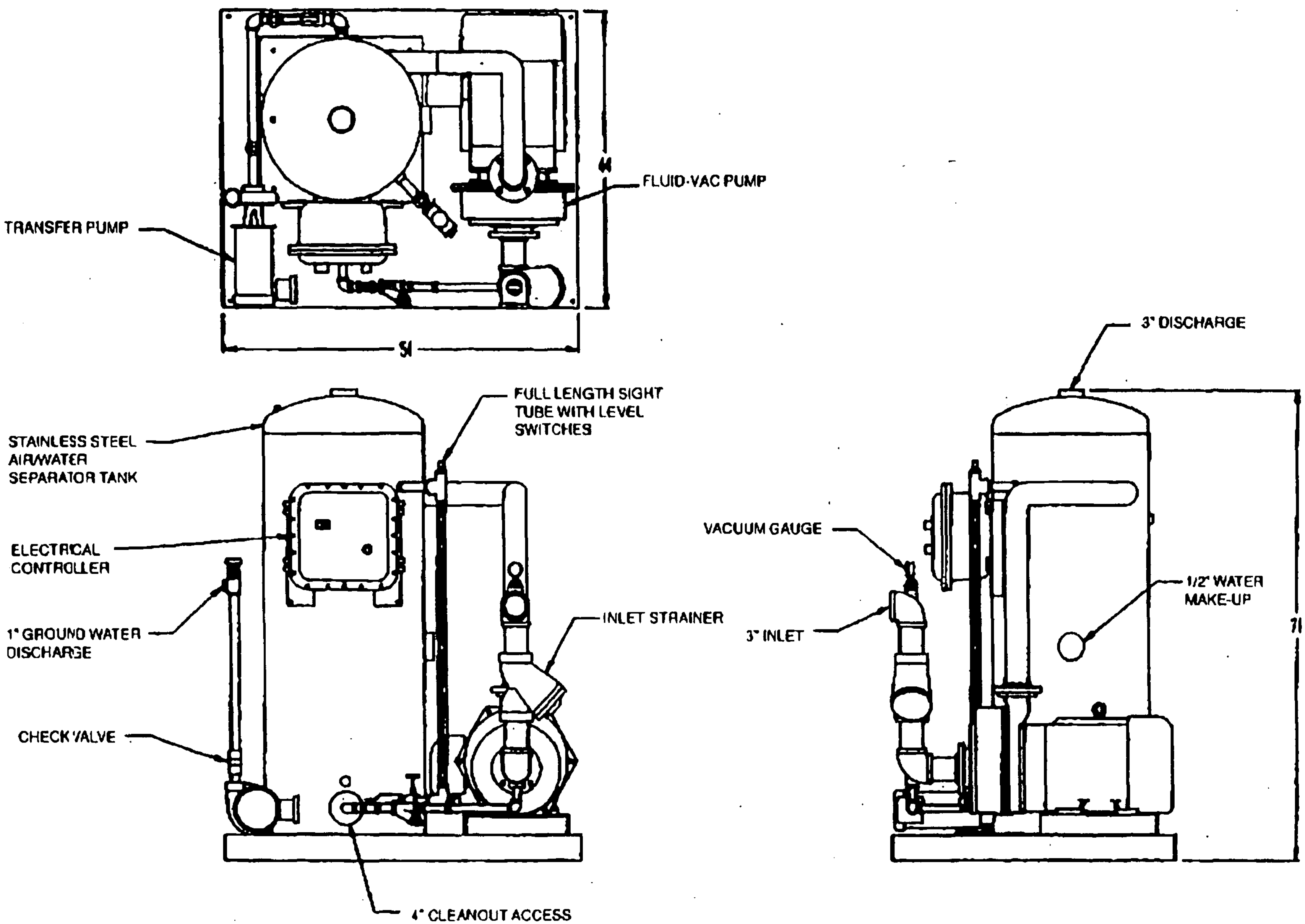
Printed in U.S.A.

A200 SIMPLEX SOIL REMEDIATION PACKAGE SPECIFICATIONS



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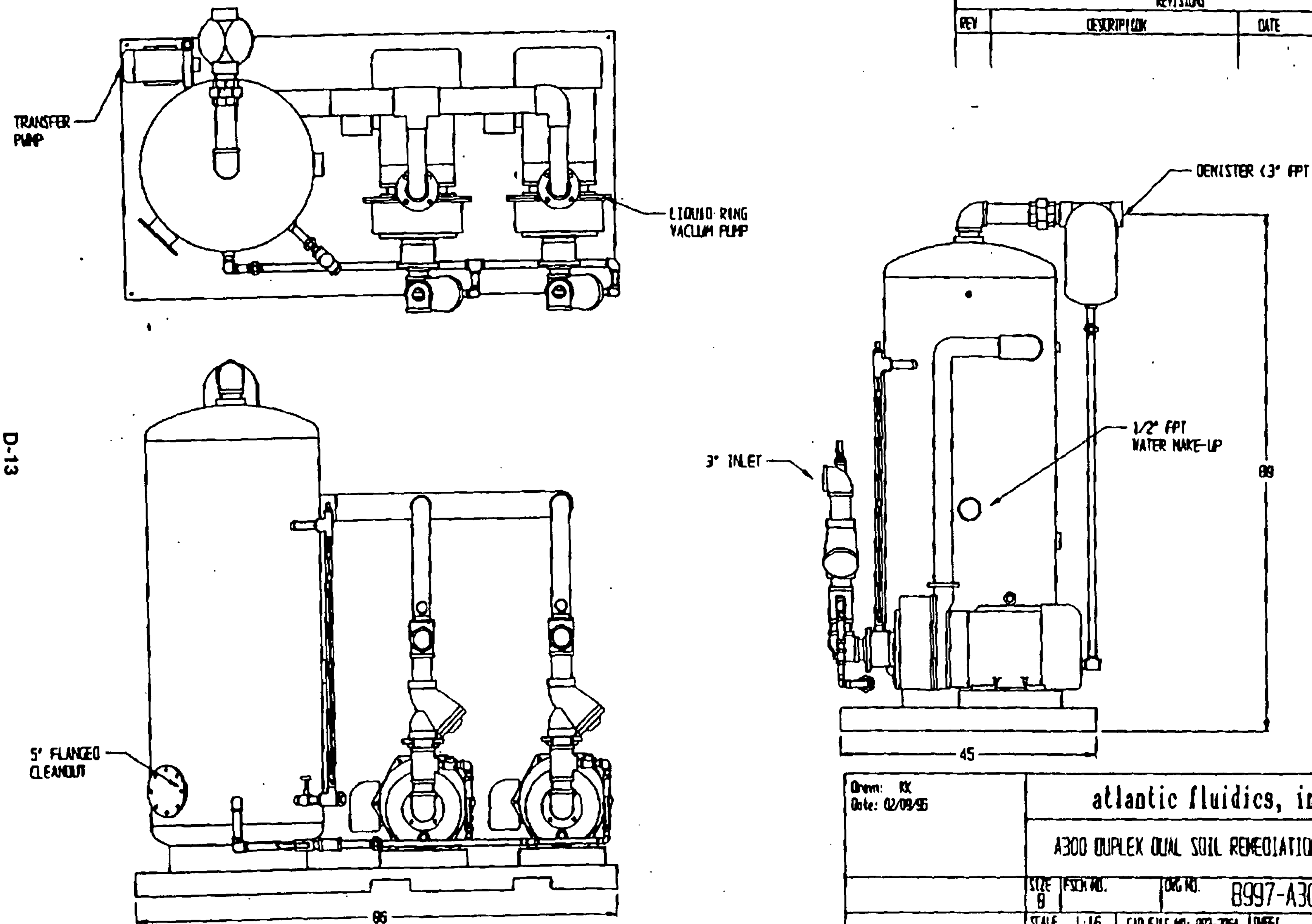

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

Drawn: KK
Date: 02/09/95

atlantic fluidics, inc.

A300 DUPLEX DUAL SOIL REMEDIATION PACKAGE

SIZE B	FSCM NO.	DWG NO. 8997-A300-01	REV A
SCALE 1:16	CAD FILE NO: 997-296A	SHEET 1 of 1	

D-13

APPENDIX D-II

SOIL CLEANUP TIME ESTIMATE

Appendix D-II

Soil Vapor Extraction
Cleanup-Time Estimate

An estimation of the time to recover vadose zone contamination was performed with the aid of the computer program "VENTING". This program estimates the rates of hydrocarbon recovery from the unsaturated zone by vacuum extraction based on methods described by Johnson et al (1990a, b). VENTING uses the following differential equation to describe change in mass with time:

$$\frac{dM_i}{dt} = -Q\,C_i$$

Where M_i is the total number of moles of component i in the soil
Q is the total gas flow rate through the contaminated zone
C_i is the molar concentration of component i in the gas phase
t is the time

To solve this equation, VENTING uses the following weighted implicit difference equation:

$$M^{t+\Delta t} = \frac{1 - (1-\mu)\,Q\dfrac{P_i^v}{RTM_T^t}\,\Delta t}{1 + \mu\,Q\dfrac{P_i^v}{RTM_T^t}\,\Delta t}$$

Where $M_i^{t+\Delta t}$ is the total number of moles of compound i at time t+dt
u is the time-weighing factor
P_i^v is the vapor pressure of compound i
R is the gas constant
T is the absolute temperature in the soil-water system
M_T^t is the total moles of all compounds in the soil at time t
Δt is the change in time

The total mass after time t, is determined by summing the concentrations of all of the compounds.

VENTING input parameter values are listed in this Appendix include the following:

- Air flow rate
- Spill Mass
- Venting period
- Temperature
- Spill composition file
- Minimum time step
- Maximum time step
- Frequency of printout
- Time weighing factor

- Biodecay factor
- Venting efficiency factor

The air flow rate, Q, is the volume of gas under standard temperature and pressure conditions (STP) pumped per unit time from the venting system which passes through the contaminated zone. Since a large portion of the air flow will pass through clean soil, a site-specific air flow correction factor (typically between 0.1 to 0.5) will be multiplied to the anticipated flow rate. Venting allows the air flow rate to be input directly or calculated from the radial single well flow equation. In the latter case, air permeability is needed which can be input directly or estimated from a field gas flow test.

Spill mass is the total mass of hydrocarbon present in the soil at the time the in situ vacuum system begins operation. Since the predicted removal time for a given compound will be proportional to its mass, uncertainty in removal time will be proportionate to the uncertainty in spill mass. The estimated mass of hydrocarbons in the vadose zone soil is calculated in Appendix A-I.

The venting period is the total duration of the simulation.

The temperature of the soil-gas system in the zone of contamination must be input for the model. Normally this would correspond to ambient soil conditions unless consideration is being given to hot air or other thermalization methods.

Three (3) spill composition files are available with the program, one library file, one fresh gasoline and one weathered gasoline file. The content of these files are presented in Johnson et al (1990, a,b). New files containing site-specific chemical data may be created from the library file.

Minimum time step is the initial step employed in the finite difference solution of the mass balance equation. The maximum time step employed is the maximum time step employed by the finite difference solution which will normally adjust the time step automatically subject to the imposed minimum and maximum constraints.

The frequency of printout parameter is designed to minimize the volume of output. VENTING will OUTPUT information on the total hydrocarbon remaining in the soil at every time step but will write details of the compositional breakdown only at the frequency prescribed by this parameter.

The time weighing factor is a constant which the authors recommend between 0.5 and 1.0.

The Biodecay factor imposes simultenous reduction in contamination due to biological degradation. A factor of 1.0 indicates 100 percent biological degradation, and a factor of 0 indicates zero percent biodegradation.

The Venting efficiency factor accounts for the placement of the venting wells over the area of contamiation.

Assumptions of this model include:

- Equilibrium partitioning between the gas and residual organic liquid
- Homogeneous and isotropic vadose zone
- Vapor phase behavior as an ideal gas
- Proportion of mass which is dissolved into soil moisture or adsorbed is negligible.

A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems, *by P.C. Johnson, C.C. Stanley, M.W. Kemblowski, D.L. Byers, and J.D. Colthart, Ground Water Monitoring Review, Vol X No. 2, Spring 1990, pp 159.*

VENTING

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Environmental Systems and Technologies Inc.

2701 RAMBLE ROAD, SUITE 2

BLACKSBURG, VA 24062, U.S.A.

TITLE: FACILITY 325

TOTAL MASS OF SPILL	=	.20560E+04	[kg]
AIR FLOW RATE	=	.89718E+07	[L/day]
TEMPERATURE	=	.20000E+02	[c]
STARTING TIME STEP	=	.10000E-04	[days]
MAXIMUM TIME STEP	=	.10000E+02	[days]
TOTAL SIMULATION TIME	=	.36000E+03	[days]
TIME WEIGHTING FACTOR	=	.10000E+01	[-]
EFFICIENCY FACTOR	=	.50000E+00	[-]
BIODECAY EFF. FACTOR	=	.00000E+00	[-]
SOIL VOLUME	=	.23912E+04	[m^3]
FRAC. ORGANIC CARBON	=	.60000E-03	[-]
VOL. WATER CONTENT	=	.10000E+00	[-]
BULK DENSITY	=	.17225E+01	[g/cm^3]
AIR FILLED POROSITY	=	.25000E+00	[-]

SPECIES	MOL. WEIGHT gm/mole	-|- VAP PRESSURE atm	-|- BOILING-TEMP deg. c	|-SOLUBILITY mg/L	-|-
3-methylpentane	.8620E+02	.2000E+00	.6400E+02	.1300E+02	.64
2-methylpentane	.8620E+02	.2100E+00	.6000E+02	.1400E+02	.64
n-hexane	.8620E+02	.1600E+00	.6870E+02	.1300E+02	.87
benzene	.7810E+02	.1000E+00	.8010E+02	.1780E+04	.13
toluene	.9210E+02	.2900E-01	.1110E+03	.5150E+03	.49
ethylbenzene	.1062E+03	.1120E-01	.1362E+03	.1520E+03	.14
o-xylene	.1062E+03	.7000E-03	.1440E+03	.1750E+03	.89
napthalene	.1282E+03	.1400E-03	.2180E+03	.3300E+02	.17
1-methylnaphthalene	.1422E+03	.5000E-04	.2446E+03	.2500E+02	.74
2-methylnaphthalene	.1422E+03	.5000E-04	.2410E+03	.2700E+02	.79

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.8224E+05	.0000E+00	.0000E+00	.1997E+02
2-methylpentane	.1439E+06	.0000E+00	.0000E+00	.3494E+02
n-hexane	.1234E+06	.0000E+00	.0000E+00	.2995E+02
benzene	.3084E+06	.0000E+00	.0000E+00	.7488E+02
toluene	.3084E+06	.0000E+00	.0000E+00	.7488E+02
ethylbenzene	.3084E+06	.0000E+00	.0000E+00	.7488E+02
o-xylene	.3084E+06	.0000E+00	.0000E+00	.7488E+02

napthalene	.2262E+06	.0000E+00	.0000E+00	.5491E+02
1-methylnaphthalene	.1234E+06	.0000E+00	.0000E+00	.2995E+02
2-methylnaphthalene	.1234E+06	.0000E+00	.0000E+00	.2995E+02

```
TIME                                    =       .0000   [days]
TOTAL MASS OF HYDROCARBON               =  .20560E+04   [kg]
TOTAL MASS IN VAPOR PHASE               =  .11745E+03   [kg]
TOTAL MASS IN OIL PHASE                 =  .15817E+04   [kg]
TOTAL MASS IN WATER PHASE               =  .93321E+02   [kg]
TOTAL MASS IN SOLID PHASE               =  .27006E+03   [kg]
HYDROCARBON MASS PER SOIL MASS          =  .49917E+03   [mg/kg]
```

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.8224E+05	.1548E-03	.3096E-03	.1997E+02
2-methylpentane	.1439E+06	.2803E-03	.5606E-03	.3494E+02
n-hexane	.1234E+06	.1900E-03	.3800E-03	.2995E+02
benzene	.3084E+06	.2274E-03	.4548E-03	.7488E+02
toluene	.3084E+06	.8521E-04	.1704E-03	.7488E+02
ethylbenzene	.3084E+06	.3757E-04	.7514E-04	.7488E+02
o-xylene	.3084E+06	.2890E-05	.5780E-05	.7488E+02
napthalene	.2262E+06	.0000E+00	.0000E+00	.5491E+02
1-methylnaphthalene	.1234E+06	.0000E+00	.0000E+00	.2995E+02
2-methylnaphthalene	.1234E+06	.0000E+00	.0000E+00	.2995E+02

SPECIES	SPECIES MASS [g] IN GAS	OIL	WATER	SOLID
3-methylpentane	.1859E+05	.5806E+05	.1349E+03	.5672E+04
2-methylpentane	.3361E+05	.9995E+05	.2501E+03	.1052E+05
n-hexane	.2279E+05	.8895E+05	.2067E+03	.1172E+05
benzene	.2743E+05	.1713E+06	.6017E+05	.5289E+05
toluene	.1020E+05	.2197E+06	.1893E+05	.6039E+05
ethylbenzene	.4464E+04	.2489E+06	.5490E+04	.5005E+05
o-xylene	.2949E+03	.2631E+06	.6681E+04	.3872E+05
napthalene	.4835E+02	.2157E+06	.8555E+03	.9681E+04
1-methylnaphthalene	.8723E+01	.1089E+06	.2951E+03	.1425E+05
2-methylnaphthalene	.8567E+01	.1070E+06	.3131E+03	.1619E+05

```
********************************************
       end of initial conditions
********************************************
```

```
TIME                                    =      2.0000   [days]
TOTAL MASS OF HYDROCARBON               =  .13075E+04   [kg]
TOTAL MASS IN VAPOR PHASE               =  .52973E+02   [kg]
TOTAL MASS IN OIL PHASE                 =  .10037E+04   [kg]
TOTAL MASS IN WATER PHASE               =  .73190E+02   [kg]
TOTAL MASS IN SOLID PHASE               =  .27607E+03   [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP=  .12764E+02   [%]
CUMULATIVE CHANGE IN HYDROCARBON        =  .36404E+02   [%]
HYDROCARBON MASS PER SOIL MASS          =  .31745E+03   [mg/kg]
```

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]

3-methylpentane	.7704E+04	.2056E+01	.4111E+01	.1871E+01
2-methylpentane	.1299E+05	.3556E+01	.7111E+01	.3154E+01
n-hexane	.1501E+05	.3302E+01	.6605E+01	.3644E+01
benzene	.9280E+05	.8854E+01	.1771E+02	.2253E+02
toluene	.1736E+06	.6801E+01	.1360E+02	.4214E+02
ethylbenzene	.2320E+06	.4219E+01	.8438E+01	.5632E+02
o-xylene	.3021E+06	.3740E+00	.7480E+00	.7335E+02
napthalene	.2251E+06	.6669E-01	.1334E+00	.5464E+02
1-methylnaphthalene	.1232E+06	.1150E-01	.2300E-01	.2990E+02
2-methylnaphthalene	.1232E+06	.1118E-01	.2235E-01	.2990E+02

TIME	=	4.0000	[days]
TOTAL MASS OF HYDROCARBON	=	.10351E+04	[kg]
TOTAL MASS IN VAPOR PHASE	=	.17132E+02	[kg]
TOTAL MASS IN OIL PHASE	=	.73256E+03	[kg]
TOTAL MASS IN WATER PHASE	=	.42042E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.25434E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.51990E+01	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.49654E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.25131E+03	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.5145E+03	.1122E+00	.2243E+00	.1249E+00
2-methylpentane	.8411E+03	.1871E+00	.3742E+00	.2042E+00
n-hexane	.1313E+04	.2377E+00	.4755E+00	.3188E+00
benzene	.2388E+05	.1750E+01	.3499E+01	.5798E+01
toluene	.8576E+05	.2754E+01	.5508E+01	.2082E+02
ethylbenzene	.1599E+06	.2499E+01	.4998E+01	.3881E+02
o-xylene	.2937E+06	.3206E+00	.6413E+00	.7130E+02
napthalene	.2234E+06	.6236E-01	.1247E+00	.5425E+02
1-methylnaphthalene	.1229E+06	.1031E-01	.2061E-01	.2984E+02
2-methylnaphthalene	.1229E+06	.9921E-02	.1984E-01	.2984E+02

TIME	=	7.7500	[days]
TOTAL MASS OF HYDROCARBON	=	.84403E+03	[kg]
TOTAL MASS IN VAPOR PHASE	=	.66692E+01	[kg]
TOTAL MASS IN OIL PHASE	=	.57535E+03	[kg]
TOTAL MASS IN WATER PHASE	=	.28108E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.23573E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.43977E+01	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.58948E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.20492E+03	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.3006E-02	.6012E-02	.0000E+00
2-methylpentane	.0000E+00	.4839E-02	.9678E-02	.0000E+00
n-hexane	.0000E+00	.8902E-02	.1780E-01	.0000E+00
benzene	.2769E+04	.2198E+00	.4395E+00	.6722E+00
toluene	.2422E+05	.8802E+00	.1760E+01	.5879E+01
ethylbenzene	.7680E+05	.1407E+01	.2814E+01	.1865E+02
o-xylene	.2759E+06	.3604E+00	.7208E+00	.6699E+02
napthalene	.2197E+06	.7760E-01	.1552E+00	.5334E+02
1-methylnaphthalene	.1223E+06	.1245E-01	.2491E-01	.2969E+02
2-methylnaphthalene	.1223E+06	.1190E-01	.2379E-01	.2970E+02

TIME	=	16.1875	[days]
TOTAL MASS OF HYDROCARBON	=	.70653E+03	[kg]
TOTAL MASS IN VAPOR PHASE	=	.24114E+01	[kg]
TOTAL MASS IN OIL PHASE	=	.46263E+03	[kg]
TOTAL MASS IN WATER PHASE	=	.21213E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.22080E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.30882E+01	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.65636E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.17154E+03	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.8794E+02	.7404E-02	.1481E-01	.2135E-01
toluene	.2409E+04	.9625E-01	.1925E+00	.5848E+00
ethylbenzene	.1705E+05	.3541E+00	.7082E+00	.4139E+01
o-xylene	.2356E+06	.3555E+00	.7111E+00	.5719E+02
napthalene	.2098E+06	.9060E-01	.1812E+00	.5095E+02
1-methylnaphthalene	.1207E+06	.1441E-01	.2882E-01	.2931E+02
2-methylnaphthalene	.1208E+06	.1367E-01	.2733E-01	.2934E+02

TIME	=	33.7813	[days]
TOTAL MASS OF HYDROCARBON	=	.58943E+03	[kg]
TOTAL MASS IN VAPOR PHASE	=	.88071E+00	[kg]
TOTAL MASS IN OIL PHASE	=	.39040E+03	[kg]
TOTAL MASS IN WATER PHASE	=	.17537E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.20529E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.28413E+01	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.71331E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.14311E+03	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.6894E+02	.4404E-02	.8808E-02	.1674E-01
ethylbenzene	.1317E+04	.4475E-01	.8950E-01	.3198E+00
o-xylene	.1657E+06	.4152E+00	.8305E+00	.4023E+02
napthalene	.1878E+06	.1411E+00	.2822E+00	.4560E+02
1-methylnaphthalene	.1171E+06	.2347E-01	.4695E-01	.2843E+02
2-methylnaphthalene	.1174E+06	.2216E-01	.4432E-01	.2851E+02

TIME	=	53.7813	[days]
TOTAL MASS OF HYDROCARBON	=	.49335E+03	[kg]
TOTAL MASS IN VAPOR PHASE	=	.69071E+00	[kg]
TOTAL MASS IN OIL PHASE	=	.30537E+03	[kg]
TOTAL MASS IN WATER PHASE	=	.15416E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.20472E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.22144E+01	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.76004E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.11978E+03	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.7069E+02	.2687E-02	.5375E-02	.1716E-01
o-xylene	.1063E+06	.3046E+00	.6091E+00	.2580E+02
napthalene	.1614E+06	.1494E+00	.2987E+00	.3918E+02
1-methylnaphthalene	.1125E+06	.2625E-01	.5249E-01	.2732E+02
2-methylnaphthalene	.1131E+06	.2461E-01	.4921E-01	.2746E+02

```
TIME                                        =    73.7813   [days]
TOTAL MASS OF HYDROCARBON                   = .41030E+03   [kg]
TOTAL MASS IN VAPOR PHASE                   = .56841E+00   [kg]
TOTAL MASS IN OIL PHASE                     = .20621E+03   [kg]
TOTAL MASS IN WATER PHASE                   = .12778E+02   [kg]
TOTAL MASS IN SOLID PHASE                   = .20214E+03   [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP    = .19076E+01   [%]
CUMULATIVE CHANGE IN HYDROCARBON            = .80044E+02   [%]
HYDROCARBON MASS PER SOIL MASS              = .99615E+02   [mg/kg]
```

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.6317E+05	.2148E+00	.4296E+00	.1534E+02
napthalene	.1319E+06	.1636E+00	.3273E+00	.3201E+02
1-methylnaphthalene	.1071E+06	.3046E-01	.6092E-01	.2601E+02
2-methylnaphthalene	.1081E+06	.2825E-01	.5649E-01	.2625E+02

time step reduced

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TIME                                        =    82.7813   [days]
TOTAL MASS OF HYDROCARBON                   = .39809E+03   [kg]
TOTAL MASS IN VAPOR PHASE                   = .10718E+01   [kg]
TOTAL MASS IN OIL PHASE                     = .00000E+00   [kg]
TOTAL MASS IN WATER PHASE                   = .22928E+02   [kg]
TOTAL MASS IN SOLID PHASE                   = .37409E+03   [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP    = .39119E+00   [%]
CUMULATIVE CHANGE IN HYDROCARBON            = .80638E+02   [%]
HYDROCARBON MASS PER SOIL MASS              = .96651E+02   [mg/kg]
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SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.5882E+05	.2117E+00	.4234E+00	.1428E+02

napthalene	.1253E+06	.3192E+00	.6385E+00	.3043E+02
1-methylnaphthalene	.1064E+06	.3558E-01	.7116E-01	.2584E+02
2-methylnaphthalene	.1075E+06	.3110E-01	.6220E-01	.2610E+02

TIME	=	86.5313	[days]
TOTAL MASS OF HYDROCARBON	=	.37073E+03	[kg]
TOTAL MASS IN VAPOR PHASE	=	.94245E+00	[kg]
TOTAL MASS IN OIL PHASE	=	.00000E+00	[kg]
TOTAL MASS IN WATER PHASE	=	.20307E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.34948E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.77395E+00	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.81969E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.90008E+02	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.4945E+05	.1780E+00	.3560E+00	.1201E+02
napthalene	.1107E+06	.2819E+00	.5638E+00	.2687E+02
1-methylnaphthalene	.1047E+06	.3499E-01	.6997E-01	.2541E+02
2-methylnaphthalene	.1059E+06	.3065E-01	.6130E-01	.2572E+02

TIME	=	94.9688	[days]
TOTAL MASS OF HYDROCARBON	=	.32201E+03	[kg]
TOTAL MASS IN VAPOR PHASE	=	.72007E+00	[kg]
TOTAL MASS IN OIL PHASE	=	.00000E+00	[kg]
TOTAL MASS IN WATER PHASE	=	.15812E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.30548E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.13305E+01	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.84338E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.78180E+02	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.3413E+05	.1228E+00	.2457E+00	.8287E+01
napthalene	.8453E+05	.2153E+00	.4306E+00	.2052E+02
1-methylnaphthalene	.1008E+06	.3370E-01	.6739E-01	.2447E+02
2-methylnaphthalene	.1026E+06	.2967E-01	.5934E-01	.2490E+02

TIME	=	109.7946	[days]
TOTAL MASS OF HYDROCARBON	=	.26350E+03	[kg]
TOTAL MASS IN VAPOR PHASE	=	.47165E+00	[kg]
TOTAL MASS IN OIL PHASE	=	.00000E+00	[kg]
TOTAL MASS IN WATER PHASE	=	.10798E+02	[kg]
TOTAL MASS IN SOLID PHASE	=	.25223E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.12450E+01	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.87184E+02	[%]

HYDROCARBON MASS PER SOIL MASS = .63975E+02 [mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.1848E+05	.7216E-01	.1443E+00	.4487E+01
napthalene	.5375E+05	.1485E+00	.2970E+00	.1305E+02
1-methylnaphthalene	.9439E+05	.3423E-01	.6846E-01	.2292E+02
2-methylnaphthalene	.9688E+05	.3040E-01	.6081E-01	.2352E+02

TIME = 129.3185 [days]
TOTAL MASS OF HYDROCARBON = .21523E+03 [kg]
TOTAL MASS IN VAPOR PHASE = .29141E+00 [kg]
TOTAL MASS IN OIL PHASE = .00000E+00 [kg]
TOTAL MASS IN WATER PHASE = .71465E+01 [kg]
TOTAL MASS IN SOLID PHASE = .20779E+03 [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP = .10129E+01 [%]
CUMULATIVE CHANGE IN HYDROCARBON = .89532E+02 [%]
HYDROCARBON MASS PER SOIL MASS = .52255E+02 [mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.8520E+04	.4381E-01	.8761E-01	.2068E+01
napthalene	.3018E+05	.1098E+00	.2196E+00	.7326E+01
1-methylnaphthalene	.8662E+05	.4137E-01	.8273E-01	.2103E+02
2-methylnaphthalene	.8992E+05	.3716E-01	.7432E-01	.2183E+02

TIME = 149.3185 [days]
TOTAL MASS OF HYDROCARBON = .18323E+03 [kg]
TOTAL MASS IN VAPOR PHASE = .19218E+00 [kg]
TOTAL MASS IN OIL PHASE = .00000E+00 [kg]
TOTAL MASS IN WATER PHASE = .51064E+01 [kg]
TOTAL MASS IN SOLID PHASE = .17793E+03 [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP = .70142E+00 [%]
CUMULATIVE CHANGE IN HYDROCARBON = .91088E+02 [%]
HYDROCARBON MASS PER SOIL MASS = .44485E+02 [mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00

toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.3867E+04	.2088E-01	.4175E-01	.9388E+00
napthalene	.1674E+05	.6394E-01	.1279E+00	.4063E+01
1-methylnaphthalene	.7932E+05	.3978E-01	.7955E-01	.1926E+02
2-methylnaphthalene	.8330E+05	.3615E-01	.7230E-01	.2022E+02

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TIME                                         =   169.3185   [days]
TOTAL MASS OF HYDROCARBON                    = .16085E+03   [kg]
TOTAL MASS IN VAPOR PHASE                    = .13731E+00   [kg]
TOTAL MASS IN OIL PHASE                      = .00000E+00   [kg]
TOTAL MASS IN WATER PHASE                    = .39435E+01   [kg]
TOTAL MASS IN SOLID PHASE                    = .15677E+03   [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP     = .50117E+00   [%]
CUMULATIVE CHANGE IN HYDROCARBON             = .92176E+02   [%]
HYDROCARBON MASS PER SOIL MASS               = .39053E+02   [mg/kg]
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SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.1755E+04	.9475E-02	.1895E-01	.4261E+00
napthalene	.9282E+04	.3546E-01	.7092E-01	.2253E+01
1-methylnaphthalene	.7264E+05	.3642E-01	.7285E-01	.1764E+02
2-methylnaphthalene	.7718E+05	.3349E-01	.6698E-01	.1874E+02

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TIME                                         =   189.3185   [days]
TOTAL MASS OF HYDROCARBON                    = .14396E+03   [kg]
TOTAL MASS IN VAPOR PHASE                    = .10563E+00   [kg]
TOTAL MASS IN OIL PHASE                      = .00000E+00   [kg]
TOTAL MASS IN WATER PHASE                    = .32375E+01   [kg]
TOTAL MASS IN SOLID PHASE                    = .14062E+03   [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP     = .38553E+00   [%]
CUMULATIVE CHANGE IN HYDROCARBON             = .92998E+02   [%]
HYDROCARBON MASS PER SOIL MASS               = .34953E+02   [mg/kg]
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SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.7965E+03	.4300E-02	.8600E-02	.1934E+00
napthalene	.5148E+04	.1967E-01	.3934E-01	.1250E+01
1-methylnaphthalene	.6652E+05	.3336E-01	.6671E-01	.1615E+02
2-methylnaphthalene	.7150E+05	.3103E-01	.6205E-01	.1736E+02

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TIME                                         =   209.3185   [days]
TOTAL MASS OF HYDROCARBON                    = .13037E+03   [kg]
TOTAL MASS IN VAPOR PHASE                    = .86262E-01   [kg]
TOTAL MASS IN OIL PHASE                      = .00000E+00   [kg]
TOTAL MASS IN WATER PHASE                    = .27752E+01   [kg]
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TOTAL MASS IN SOLID PHASE	= .12751E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	= .31484E+00	[%]
CUMULATIVE CHANGE IN HYDROCARBON	= .93659E+02	[%]
HYDROCARBON MASS PER SOIL MASS	= .31653E+02	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.3615E+03	.1952E-02	.3903E-02	.8777E-01
napthalene	.2855E+04	.1091E-01	.2182E-01	.6932E+00
1-methylnaphthalene	.6091E+05	.3055E-01	.6109E-01	.1479E+02
2-methylnaphthalene	.6624E+05	.2875E-01	.5749E-01	.1608E+02

TIME	= 229.3185	[days]
TOTAL MASS OF HYDROCARBON	= .11890E+03	[kg]
TOTAL MASS IN VAPOR PHASE	= .73575E-01	[kg]
TOTAL MASS IN OIL PHASE	= .00000E+00	[kg]
TOTAL MASS IN WATER PHASE	= .24471E+01	[kg]
TOTAL MASS IN SOLID PHASE	= .11638E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	= .26854E+00	[%]
CUMULATIVE CHANGE IN HYDROCARBON	= .94217E+02	[%]
HYDROCARBON MASS PER SOIL MASS	= .28868E+02	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.1641E+03	.8858E-03	.1772E-02	.3983E-01
napthalene	.1583E+04	.6050E-02	.1210E-01	.3844E+00
1-methylnaphthalene	.5578E+05	.2797E-01	.5594E-01	.1354E+02
2-methylnaphthalene	.6137E+05	.2663E-01	.5326E-01	.1490E+02

TIME	= 249.3185	[days]
TOTAL MASS OF HYDROCARBON	= .10889E+03	[kg]
TOTAL MASS IN VAPOR PHASE	= .64616E-01	[kg]
TOTAL MASS IN OIL PHASE	= .00000E+00	[kg]
TOTAL MASS IN WATER PHASE	= .21961E+01	[kg]
TOTAL MASS IN SOLID PHASE	= .10663E+03	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	= .23584E+00	[%]
CUMULATIVE CHANGE IN HYDROCARBON	= .94704E+02	[%]
HYDROCARBON MASS PER SOIL MASS	= .26438E+02	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00

2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.7446E+02	.4020E-03	.8040E-03	.1808E-01
napthalene	.8782E+03	.3355E-02	.6710E-02	.2132E+00
1-methylnaphthalene	.5108E+05	.2562E-01	.5123E-01	.1240E+02
2-methylnaphthalene	.5686E+05	.2467E-01	.4935E-01	.1380E+02

TIME	= 269.3185	[days]
TOTAL MASS OF HYDROCARBON	= .99976E+02	[kg]
TOTAL MASS IN VAPOR PHASE	= .57817E-01	[kg]
TOTAL MASS IN OIL PHASE	= .00000E+00	[kg]
TOTAL MASS IN WATER PHASE	= .19920E+01	[kg]
TOTAL MASS IN SOLID PHASE	= .97926E+02	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	= .21102E+00	[%]
CUMULATIVE CHANGE IN HYDROCARBON	= .95137E+02	[%]
HYDROCARBON MASS PER SOIL MASS	= .24273E+02	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.3379E+02	.1825E-03	.3649E-03	.8205E-02
napthalene	.4871E+03	.1861E-02	.3722E-02	.1182E+00
1-methylnaphthalene	.4678E+05	.2346E-01	.4691E-01	.1136E+02
2-methylnaphthalene	.5268E+05	.2286E-01	.4572E-01	.1279E+02

TIME	= 289.3185	[days]
TOTAL MASS OF HYDROCARBON	= .91926E+02	[kg]
TOTAL MASS IN VAPOR PHASE	= .52335E-01	[kg]
TOTAL MASS IN OIL PHASE	= .00000E+00	[kg]
TOTAL MASS IN WATER PHASE	= .18183E+01	[kg]
TOTAL MASS IN SOLID PHASE	= .90055E+02	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	= .19101E+00	[%]
CUMULATIVE CHANGE IN HYDROCARBON	= .95529E+02	[%]
HYDROCARBON MASS PER SOIL MASS	= .22318E+02	[mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.1534E+02	.8281E-04	.1656E-03	.3724E-02
napthalene	.2701E+03	.1032E-02	.2064E-02	.6558E-01
1-methylnaphthalene	.4284E+05	.2148E-01	.4296E-01	.1040E+02
2-methylnaphthalene	.4880E+05	.2118E-01	.4235E-01	.1185E+02

TIME	= 309.3185	[days]
TOTAL MASS OF HYDROCARBON	= .84599E+02	[kg]

TOTAL MASS IN VAPOR PHASE = .47705E-01 [kg]
TOTAL MASS IN OIL PHASE = .00000E+00 [kg]
TOTAL MASS IN WATER PHASE = .16661E+01 [kg]
TOTAL MASS IN SOLID PHASE = .82885E+02 [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP = .17412E+00 [%]
CUMULATIVE CHANGE IN HYDROCARBON = .95885E+02 [%]
HYDROCARBON MASS PER SOIL MASS = .20540E+02 [mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.6961E+01	.3758E-04	.7516E-04	.1690E-02
napthalene	.1498E+03	.5724E-03	.1145E-02	.3637E-01
1-methylnaphthalene	.3923E+05	.1967E-01	.3934E-01	.9524E+01
2-methylnaphthalene	.4521E+05	.1962E-01	.3924E-01	.1098E+02

TIME = 329.3185 [days]
TOTAL MASS OF HYDROCARBON = .77895E+02 [kg]
TOTAL MASS IN VAPOR PHASE = .43649E-01 [kg]
TOTAL MASS IN OIL PHASE = .00000E+00 [kg]
TOTAL MASS IN WATER PHASE = .15296E+01 [kg]
TOTAL MASS IN SOLID PHASE = .76322E+02 [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP = .15931E+00 [%]
CUMULATIVE CHANGE IN HYDROCARBON = .96211E+02 [%]
HYDROCARBON MASS PER SOIL MASS = .18912E+02 [mg/kg]

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
napthalene	.8309E+02	.3175E-03	.6349E-03	.2017E-01
1-methylnaphthalene	.3592E+05	.1801E-01	.3603E-01	.8722E+01
2-methylnaphthalene	.4189E+05	.1818E-01	.3635E-01	.1017E+02

TIME = 349.3185 [days]
TOTAL MASS OF HYDROCARBON = .71751E+02 [kg]
TOTAL MASS IN VAPOR PHASE = .40067E-01 [kg]
TOTAL MASS IN OIL PHASE = .00000E+00 [kg]
TOTAL MASS IN WATER PHASE = .14068E+01 [kg]
TOTAL MASS IN SOLID PHASE = .70304E+02 [kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP = .14624E+00 [%]
CUMULATIVE CHANGE IN HYDROCARBON = .96510E+02 [%]
HYDROCARBON MASS PER SOIL MASS = .17420E+02 [mg/kg]

SPECIES	SPECIES MASS	WELL GAS CONCEN.	EQUIL. GAS CONCEN.	SPECIES MASS PER SOIL MASS

	[g]	[g/m^3]	[g/m^3]	[mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
napthalene	.4608E+02	.1761E-03	.3521E-03	.1119E-01
1-methylnaphthalene	.3290E+05	.1650E-01	.3299E-01	.7987E+01
2-methylnaphthalene	.3881E+05	.1684E-01	.3368E-01	.9422E+01

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
napthalene	.2556E+02	.9765E-04	.1953E-03	.6205E-02
1-methylnaphthalene	.3013E+05	.1511E-01	.3021E-01	.7314E+01
2-methylnaphthalene	.3595E+05	.1560E-01	.3120E-01	.8729E+01

...........FINAL RESULTS..........

TIME	=	369.3185	[days]
TOTAL MASS OF HYDROCARBON	=	.66105E+02	[kg]
TOTAL MASS IN VAPOR PHASE	=	.36831E-01	[kg]
TOTAL MASS IN OIL PHASE	=	.00000E+00	[kg]
TOTAL MASS IN WATER PHASE	=	.12948E+01	[kg]
TOTAL MASS IN SOLID PHASE	=	.64773E+02	[kg]
CHANGE IN HYDROCARBON MASS FOR TIME STEP	=	.13443E+00	[%]
CUMULATIVE CHANGE IN HYDROCARBON	=	.96785E+02	[%]
HYDROCARBON MASS PER SOIL MASS	=	.16049E+02	[mg/kg]

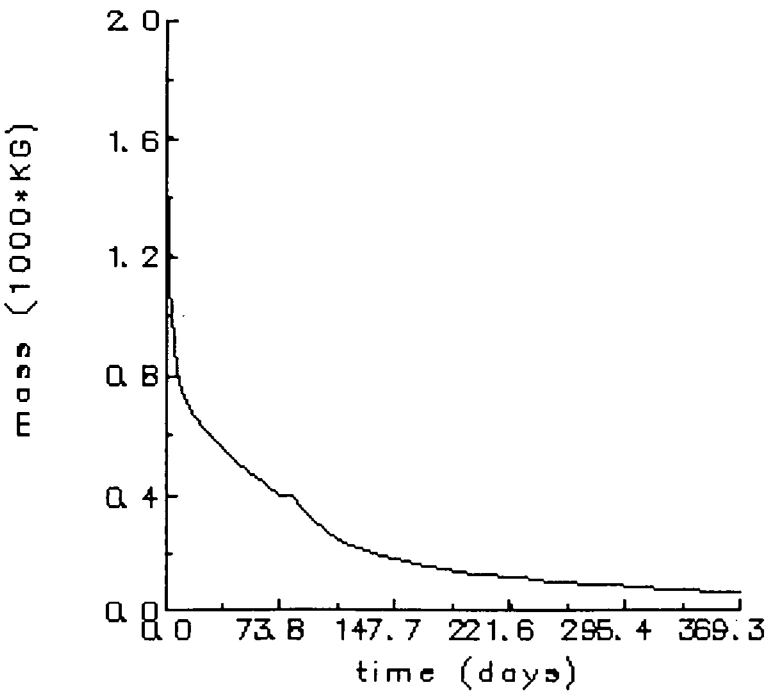
SPECIES	SPECIES MASS [g] IN GAS	OIL	WATER	SOLID
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
ethylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
o-xylene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
napthalene	.1167E+00	.0000E+00	.2066E+01	.2338E+02
1-methylnaphthalene	.1806E+02	.0000E+00	.6111E+03	.2950E+05
2-methylnaphthalene	.1865E+02	.0000E+00	.6817E+03	.3525E+05

SPECIES	SPECIES MASS [g]	WELL GAS CONCEN. [g/m^3]	EQUIL. GAS CONCEN. [g/m^3]	SPECIES MASS PER SOIL MASS [mg/kg]
3-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00

2-methylpentane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
n-hexane	.0000E+00	.0000E+00	.0000E+00	.0000E+00
benzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
toluene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
[illegible]hylbenzene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
[illegible]xylene	.0000E+00	.0000E+00	.0000E+00	.0000E+00
napthalene	.2556E+02	.9765E-04	.1953E-03	.6205E-02
1-methylnaphthalene	.3013E+05	.1511E-01	.3021E-01	.7314E+01
2-methylnaphthalene	.3595E+05	.1560E-01	.3120E-01	.8729E+01

Total number of time steps = 49
Total number of iterations = 212

Total Mass



Mass (1000*KG)
2.0
1.6
1.2
0.8
0.4
0.0
0.0
73.8
147.7
221.6
295.4
369.3
time (days)

APPENDIX D-III

AAS COMPRESSOR SIZING

APPENDIX D-IV

AAS CLEANUP TIME

Appendix D-III

Aquifer Air Sparging Compressor Sizing

Project:	CSS Panama City, Facility 325, Panama City, Florida; RAP		
Date:	5/17/96	Engineer: KGK	Checked By:

Compressor Sizing

Determination of Air Injection Pressure

Evan K. Nyer and Suthan S. Suthersan, Fall 1993 GWWR. pp 90

The injection pressure necessary to initiate in situ air sparging should be able to overcome the following:

1. The depth of water column at the point of injection
2. The frictional losses in the system
3. The capillary entry resistance to displace the pore water; depends on the type of sediments

The release pressure Pr depends on the type of geology, depth of injection, air distribution efficiency, and the frictional losses in the system. Release pressure has been found to be in the range of 2.3 feet of H_2O (1 psi) for every 3 feet of Hi for fine sands and every 5 feet of Hi for coarse gravel.

Pi = Hi + PR		
H	Depth to Point of Injection bls	25.00 ft
Hi	Water Column above AAS point	19.00 ft
PR	Release Pressure	19.17 ft of water
Pi		38.17 ft of water
Friction Lossess (assume 50%)		19.08 ft of water
Total Pressure		57.25 ft of water
		24.89 psi

Hence use 30 acfm, 25 psi compressor.

W.E.S., Inc.
ENVIRONMENTAL DIVISION

FAX COMMUNICATION

Date: 4/25/96

To: GOPI KANCHIBHATLI	From: MIKE STEVENS
Company: ABB ENVIRONMENTAL SYSTEM	Department: SALES
City, State: TALLAHASSEE FL	City, State: SARASOTA FL
Fax No. 904-877-0742	

IF YOU DO NOT RECEIVE 5 PAGES (INCLUDING THIS PAGE), PLEASE CONTACT THE APPROPRIATE OFFICE AS INDICATED BELOW.

SUBJECT: PROPOSAL FOR AIR-SPARGING SYSTEM

- ☐ For Your Information
- ☐ For Your Approval
- ☐ As Requested
- ☐ Please Call Upon Receipt
- ☐ For Your Use
- ☐ For Your Comments
- ☐ For Your Files
- ☒ Review and Advise
- ☐ Review and File
- ☐ Hard Copy Follows

MESSAGE (if blank, this is a cover sheet):

THANK YOU

☒ Corporate Office
6339 Tower Lane
Sarasota, FL 34240
(941) 371-7617
(941) 378-5218 (Fax)

☐ FL S.E. Regional Office
1421 N.W. 165th Street
Miami, FL 33169
(305) 625-7622
(305) 625-1197 (Fax)

☐ FL N.E. Regional Office
1412C Intrepid Drive
DeLand, FL 32724
(904) 738-4505
(904) 738-4679 (Fax)

☐ Kentucky Office
1115 Delaware Avenue
Lexington, KY 40505
(606) 225-9678
(606) 225-9597 (Fax)

☐ South Carolina Office
1120 West Butler Road
Suite 0
Greenville, SC 29607
(803) 277-0427
(803) 422-9266 (Fax)

☐ Georgia Office
4025 Pleasantdale Drive
Suite 250
Atlanta, GA 30340
(404) 729-9525
(404) 729-9517 (Fax)

☐ Illinois Office
3308 Union Avenue
Steger, IL 60475
(708) 754-5221
(708) 754-6581 (Fax)

☐ New Mexico Office
6121 Indian School Rd., N.E.
Suite 141-D
Albuquerque, NM 87110
(505) 881-0727
(505) 881-7490 (Fax)

☐ Arizona Office
2123 South Priest
Suite 212
Tempe, AZ 85282
(602) 829-8283
(602) 967-1470 (Fax)

(1/96)

R

W.E.S., Inc.
ENVIRONMENTAL DIVISION

April 25, 1996

ABB ENVIRONMENTAL SERVICES, INC.
2591 Executive Center Circle E.
Tallahassee, FL 32301

ATTENTION: Mr. Gopi Kanchibhatli

SUBJECT: Proposal for Air Sparging System

PROPOSAL NO.: 7993

Dear Mr. Kanchibhatli:

Thank you for allowing us the opportunity to submit a proposal for the above mentioned equipment. The following is a cost breakdown for this equipment:

Nat

WES Model SS-5040 Air Sparging System
One (1) Ingersoll Rand T-30 Air Compressor (15 hp) with after cooler
NEMA 3R enclosed motor starter with on/off control switch
Rated for 25-40 acfm @ 15 psi
80 gallon horizontal or vertical storage tank
Inlet muffler/filter
Pressure regulator
3/4" PVC (Schedule 80) piping
1 Year Extended Warranty for starter kit
Oil coalescing
Filter IR75CD

TOTAL COST $5,991.00

The above prices are valid for a period of sixty (60) days from the date quoted. Taxes and shipping have **not** been included. Delivery can be made in three (3) weeks after receipt of your purchase order. All shipments are subject to WES Standard Terms and Conditions of sale which are incorporated herein by reference. If you have any questions regarding this proposal, please do not hesitate to contact me at (941) 371-7617. Thank you, again, for this opportunity.

Sincerely,

WES, INC.

Mark A. Maus/MB

Mark A. Maus
Account Specialist

Mike Stevens

Mike Stevens
Sales Representative Coordinator

• *Corporate Headquarters* •
6389 Tower Lane • Sarasota, Florida 34240 • (941) 371-7617 • Fax (941) 378-5218

SILVER SERIES

AIR SPARGING SYSTEM

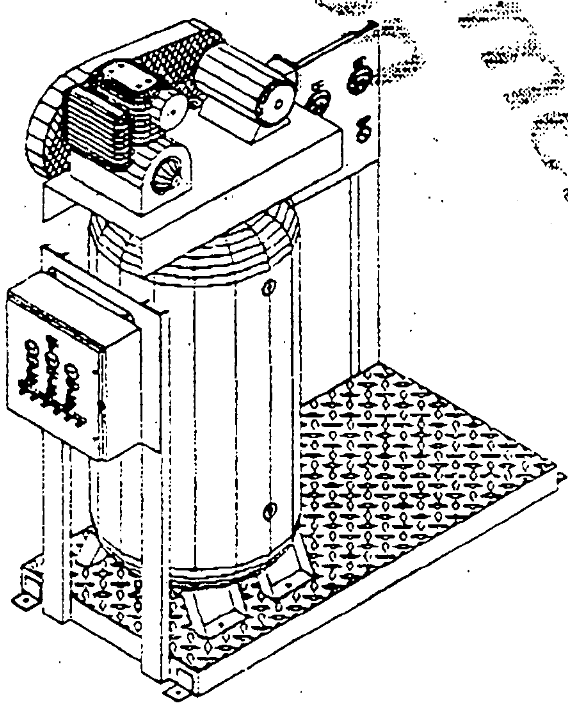
W.E.S., Inc. Environmental Division (WES) manufactures a complete line of air sparging systems suitable for use in hazardous and non-hazardous locations. The systems can be equipped with either a regenerative or positive displacement blower or an air compressor, depending on airflow and pressure requirements. For systems larger than 60 CFM, consult W.E.S., Inc. for design.

STANDARD FEATURES:

* Steel Reinforced Mounting Skid
* Blower or Compressor w/ motor
* On/Off Starter Box
* Inlet Muffler/Filter

OPTIONS:

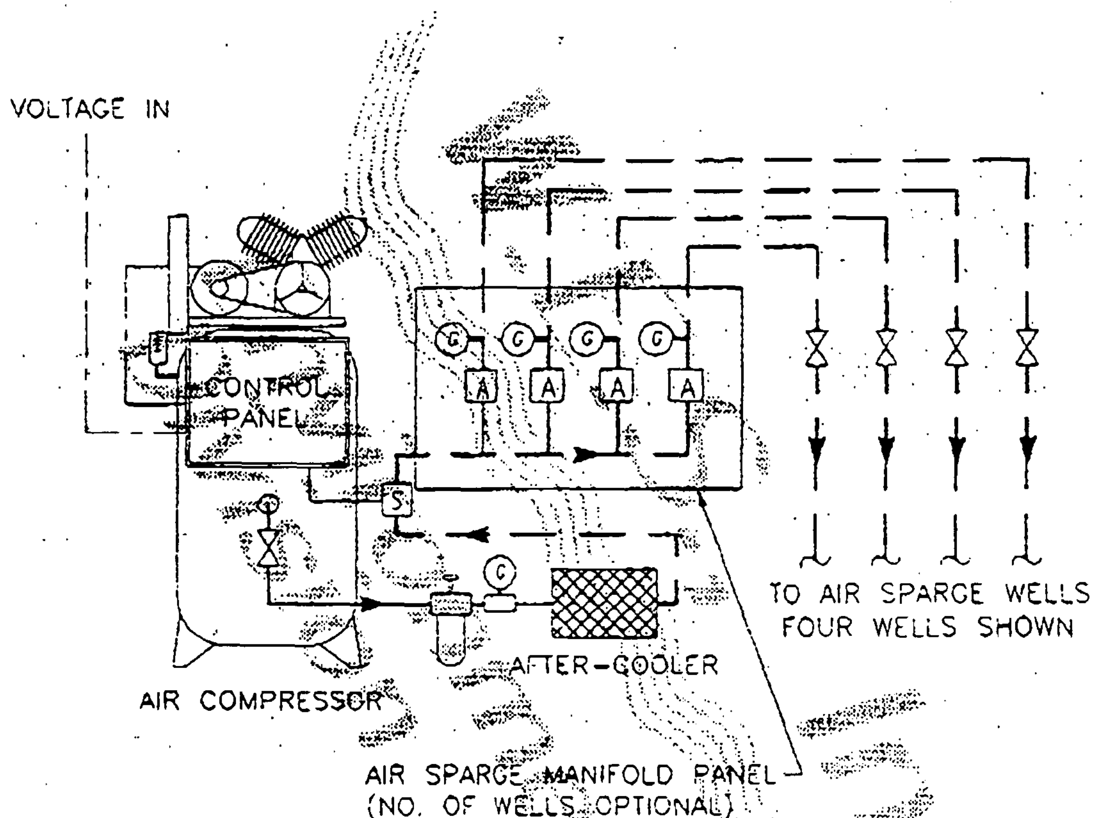
1. Electrical Control Panel
2. High Pressure Shut-off
3. High Temperature Shut-off
4. Temperature Gauge
5. Pressure Gauge
6. Flow Meter
7. Motor HP Upgrade
8. Blower Upgrade
9. Pressure Relief Valve
10. System Manifold
11. Pressure Regulator



MODEL SHOWN:
SS-5010

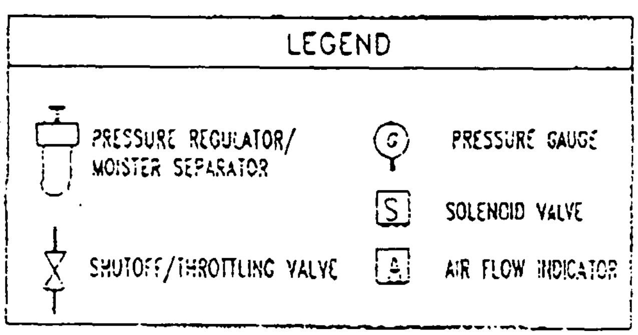
OPTIONS SHOWN:
1. Electrical Control Panel
5. Pressure Gauge
6. Flow Meter
9. System Manifold

PROCESS & INSTRUMENTATION DIAGRAM



AIR SPARGING SYSTEMS

** NOTE: PROCESS SHOWN WITH OPTIONS



W.E.S., Inc.
Environmental Division
[illegible] LANE
SARASOTA, FLORIDA 34[illegible]
PH. (813) 371-761[illegible]
FAX (813) 378-[illegible]

AIR SPARGING SYSTEM

Model: SS-5040

- One (1) Ingersoll-Rand T-30 Air Compressor (15 hp) w/ Aftercooler
- Nema3R Enclosed Motor Starter With On/Off Control Switch
- Rated for 25-40 ACFM @ 15 PSI
- 80 gal Horizontal or Vertical Air Storage Tank
- Inlet Muffler/Filter
- Pressure Regulator
- 3/4" PVC (sch 80) Piping

	PART NO.
BASE UNIT	SS5040

OPTIONS:

1.	Skid	(See Skid Section)
2.	Control Panel	(See Electrical Section)
3.	High Pressure Cut-off Switch	(See Pressure Switch Section)
4.	High Temperature Cut-off Switch	8044
5.	Temperature Gauge	8033
6.	0-100 PSI Pressure Gauge	8042
7.	Flow Meter (Rotameter)	8368
8.	Gauge Mounting Board	8312
9.	Manifold (Per Well)	8313
10.	Explosion-Proof Upgrade	(See Motor Upgrade Section)
11.	Mechanical Pressure Relief Valve	8314
12.	Solenoid Valve (non explosion-proof)	8384
13.	Solenoid Valve (explosion-proof)	8385

Appendix D–IV

Aquifer Air Sparging – Groundwater TVOA Cleanup Time Estimate

Project:	CSS Panama City, Facility 325, Panama City, Florida; RAP		
Date:	05/17/96	Engineer: KGK	Checked By:

A. Groundwater Concentrations – October 1995

MWID	Benzene	TVOA	Total napthalenes	TRPH
	ppb	ppb	ppb	ppm
MW–1	ND	ND	ND	ND
MW–2	ND	ND	ND	ND
MW–4	ND	ND	ND	ND
MW–5	ND	ND	ND	ND
MW–6	ND	ND	ND	ND
MW–8	12.00	141.00	750.00	ND
MW–9	ND	51.00	221.00	ND
MW–10	ND	52.00	164.00	ND
MW–12	1.00	38.00	64.00	8.30
MW–15	2.40	61.00	208.00	ND
MW–17	2.70	9.90	35.00	ND
MW–21	ND	127.00	176.00	ND
MW–23	20.00	151.00	614.00	ND
MW–26	11.00	143.00	265.00	6.10

Plume Avg. (shaded)	5.46	85.99	277.44	1.60
Plume Maximum	**20.00**	**151.00**	**750.00**	**8.30**

Aquifer Air Sparging – Groundwater TVOA Cleanup Time Estimate

Project:	CSS Panama City, Facility 325, Panama City, Florida; RAP		
Date:	05/17/96	Engineer: KGK	Checked By:

B. Air Sparging Model for Predicting Groundwater Cleanup Rate

by: Katherine L. Sellers and Robert P. Schreiber
Camp Dresser and McKee Inc., Cambridge, MA 02142

Assume "N" air spargers installed at depth 25 ft bls. Assume depth to water table being 6 ft bls.
Use a radius of influence of 20 ft.

N	Assume N spargers with 20 ft Roi				3.00 dimensionless
f	fraction of the contaminant plume sparged				0.21 dimensionless
	Volume covered by the TVOA (50 ppb) plume			179444.44 ft^3	
	Volume coverd by spargers (use conical volume)			3.73E+04 ft^3	
d	fraction of a 24 hr. day that the sparging is in operation (8hrs/day)				0.33 dimensionless
D	contaminant diffusion coefficient in water				1.00E–05 cm^2/s
r	average effective radius of the bubble				0.20 cm
L	diffusive distance around the bubble				0.20 cm
S/V	3/r				15.00 cm–1
v	terminal velocity of the bubble				25.00 cm/s
Vs	volume of water in contact with the bubbles (use conical volume)				6.92E+08 cm^3
	Vs =	(1/3) k (pi) (Roi)^2 H n			
	k	number of spargers		3.00	
	Roi	radius of influence, ft	20.00	614.40 cm	
	n	porosity		0.25	
	H	depth to the sparging point (blwt)		583.68 cm	
Q	air flow rate assumed		10.00 cfm		4831.84 cm^3 / s
B	f d (D/L) (S/V) (H/v) (Q/Vs)				8.47E–09 s–1
	conversion of above				**7.32E–04 d–1**

Appendix D–IV

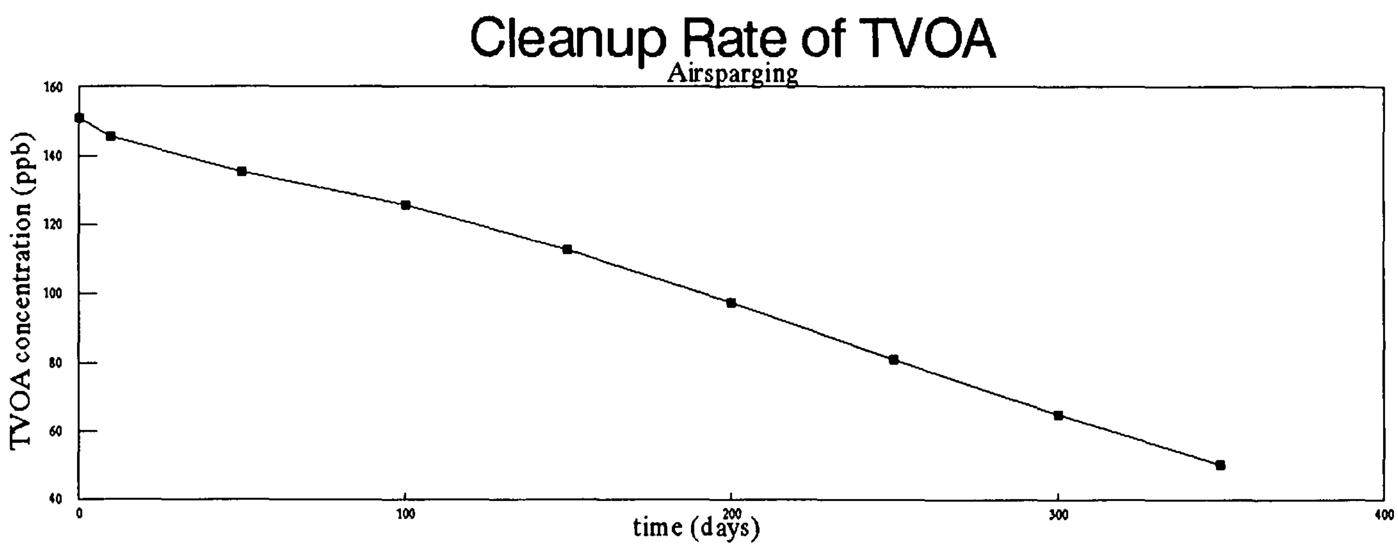
Aquifer Air Sparging – Groundwater TVOA Cleanup Time Estimate

Project:	CSS Panama City, Facility 325, Panama City, Florida; RAP		
Date:	05/17/96	Engineer: KGK	Checked By:

C. Cleanup Rate for TVOA in Groundwater

$C(t) = C(0) \exp(-Bt)$

t	C(0)	C(t) = C(0) exp(–Bt)
days	ppb	ppb
0.00	151.00	151.00
10.00	151.00	145.57
50.00	145.57	135.30
100.00	135.30	125.75
150.00	125.75	112.68
200.00	112.68	97.34
250.00	97.34	81.06
300.00	81.06	65.08
350.00	65.08	50.37



APPENDIX D-V

TOTAL FLUIDS CLEANUP

DEPARTMENT OF THE NAVY
COASTAL SYSTEMS STATION DAHLGREN DIVISION
NAVAL SURFACE WARFARE CENTER
6703 WEST HIGHWAY 98
PANAMA CITY FL 32407-7001

IN REPLY REFER TO:
5090
Ser 051E/090
7 MAY 199?

ABB Environmental Services
Attn: Mr. Gopi Kanchibhatla
Barkeley Building
2590 Executive Center Circle East
Tallahassee, FL 32301

Dear Mr. Kanchibhatla:

This letter is in reply to your request for written approval for use of the Oil Water Separator (OWS), facility #318, at the Coastal Systems Station (NSWCCSS).

Petroleum contaminated ground water pumped from sites #278 and #325 at NSWCCSS may be brought to the #318 OWS. As each tank of groundwater becomes ready for processing, please call the Public Works service desk at (904) 234-4390, to arrange for the OWS operator to conduct a field screening test and operate the OWS.

In the event that the field screening test indicates 1000 PPM or greater of chlorinated hydrocarbons, all pumping operations shall be stopped. Bechtel shall arrange for a rebuttal laboratory analysis. Pumping operations shall not continue until further disposal instructions are given by NSWCCSS.

The NSWCCSS points of contact are Mr. Bill Logsdon, Code 051EBL, at (904) 235-5474, or Mr. Mike Clayton, Code 051EMC, at (904) 235-5859.

Sincerely,

W. A. OSTER
Lieutenant Commander, U.S. Navy
By direction of
the Commanding Officer

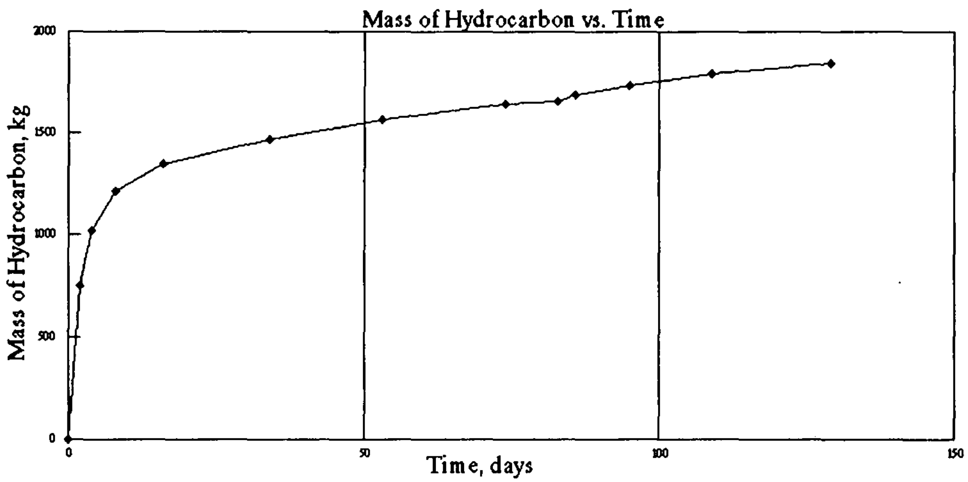
APPENDIX D-VI

VAPOR TREATMENT SYSTEM

Appendix D-VI

Vapor Treatment System - Granular Activated Carbon Adsorption
Carbon Requirements for Vapor Treatment
Facility 325, Coastal Systems Station, Panama City
Panama City, Florida

time, days	mass. kg	cumm. mas	mass removed	Carbon, kg	Carbon, kg	Carbon, lb	Canisters
0	2056	1					
2	1308	748	748	3740			
4	1035	1021	273	1365			
8	844	1212	191	955			
16	706	1350	138	690	6750	14850	7.425
34	589	1467	117	585			
53	493	1563	96	480			
74	410	1646	83	415	1480	3256	1.628
83	398	1658	12	60			
86	370	1686	28	140			
95	322	1734	48	240			
109	263	1793	59	295			
129	215	1841	48	240	975	2145	1.0725



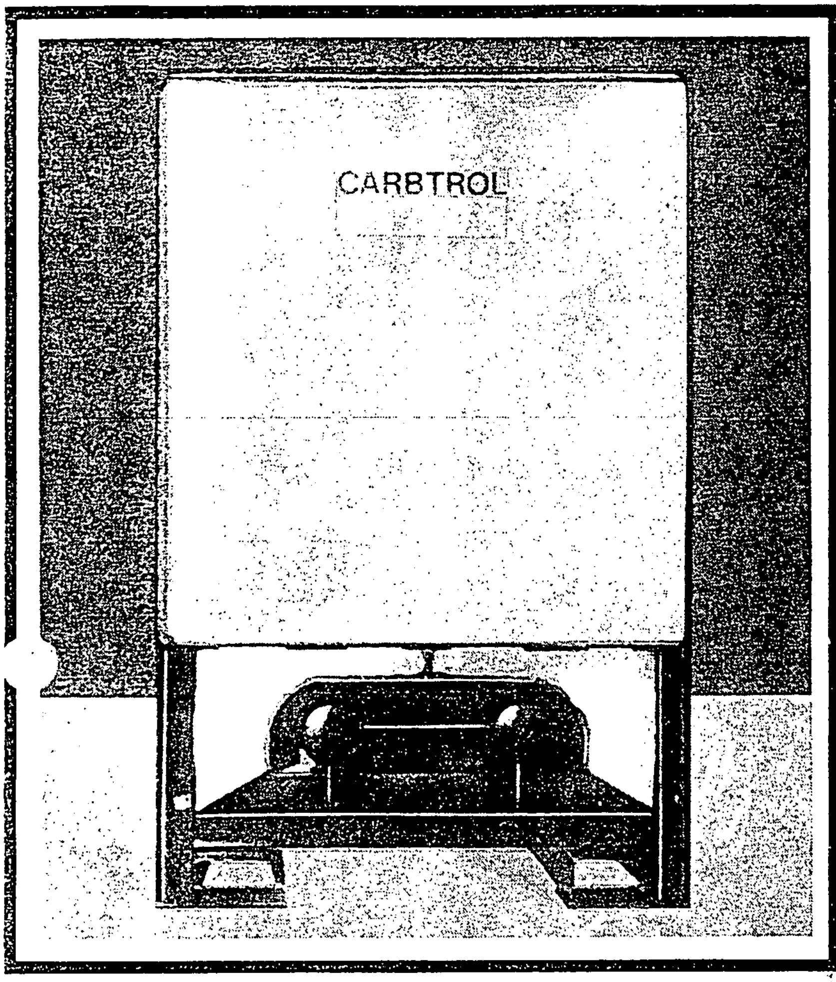
Carbon Consumption Schedule

* Install two G-5 Carbotrol Air Purifiers each containing 2000 lb Granular Activated Carbon

* Stock an additional 16,000 lb GAC for potential consumption in the first two weeks

CARBTROL®

2000 lb Activated Carbon Air Purification Adsorber G-5

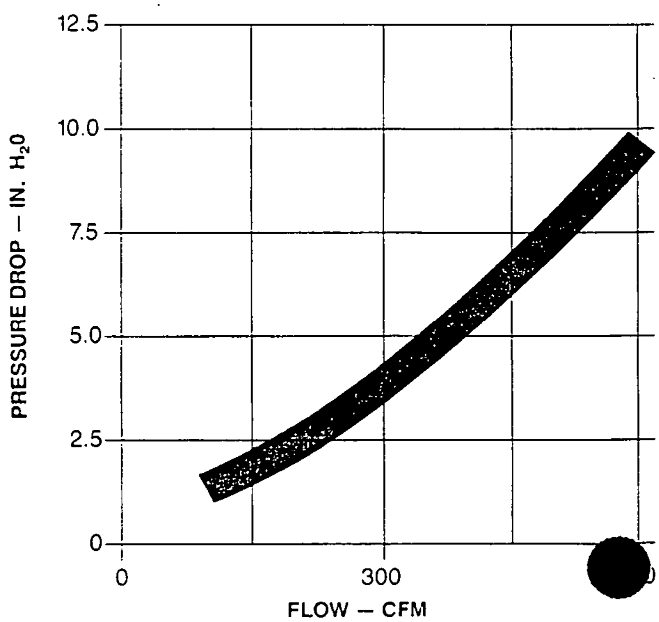


The Gas Phase (G-5) Adsorber features:

- 600 CFM at only 10″ H_2O pressure drop
- stainless or mild steel construction

also

- dump gate for easy carbon removal
- fork lift fittings for easy handling
- dual perforated inlet distributors
- DOT rating for transport
- meets reactivation quantity requirements



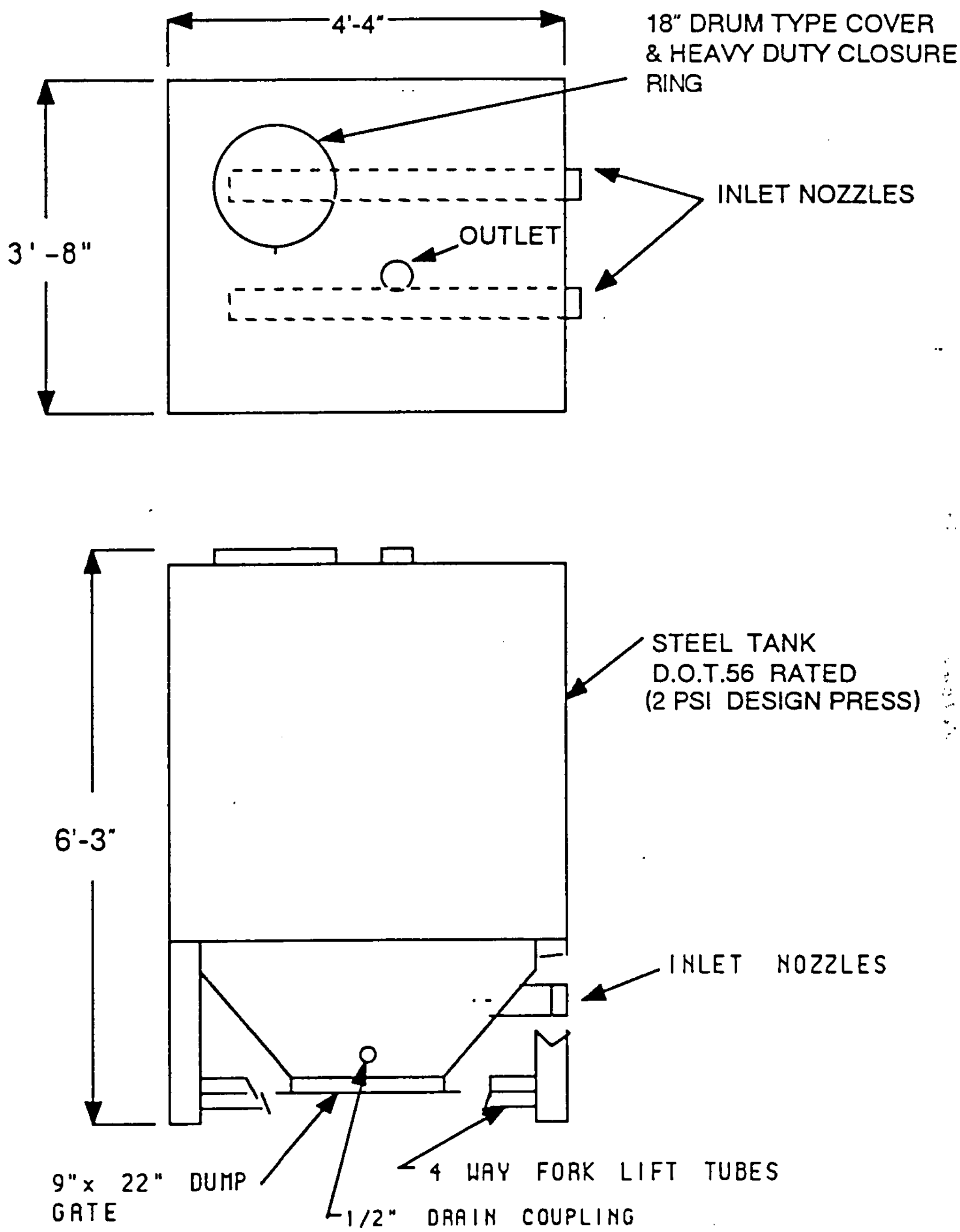
G-5 SPECIFICATIONS

Overall Dimensions	44″ x 52″ x 75″ overall height
Carbon	2000 lbs. 70 cu. ft.
Shipping weight	2650 lbs.
Connections	(2) 4″ MPT inlets (1) 6″ FPT outlet

CARBTROL CORPORATION

39 Riverside Avenue, Westport, CT 06880 • 1-800-242-1150 • (203) 226-5642

Air Purification Adsorber G-5



APPENDIX D-VII

SOIL COVER FOR SVE

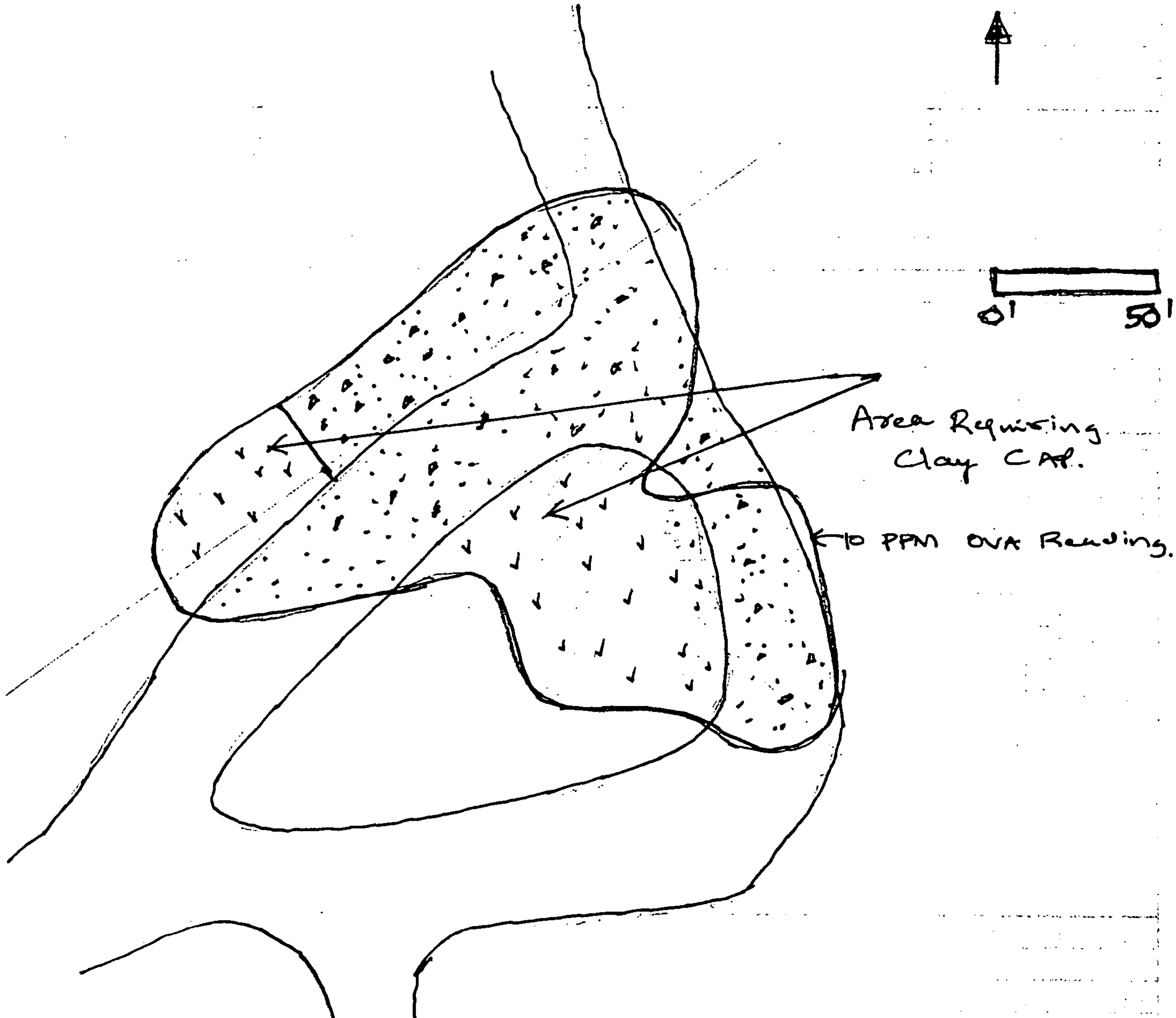
Appendix D-VII

Soil Cover for SVE

A major portion of soil contamination at Facility 325 is overlain by either a concrete cover or asphalt road way. As presented on page D-44, a minor portion (100 square yards) is covered by grass. Hence it is proposed that a flexible clay cap of thickness 1-2 feet be installed and compacted and graded to prevent potential short-circuiting of air during SVE operation.

PROJECT CSS Panama City Facility 325 RAP.	COMP. BY KGK	JOB NO. 7520.52
	CHK. BY	DATE 5/16/96

Volume of Clay for CAP on SVE Area:



Area of Clay CAP $\simeq$ 3 Sq Units

= 3X 50X50

= 750 Sq Ft = 82.8 s

Thickness of Clay layer = 2 ft

Volume of Clay = 750X2 = 1500 ft^3.

= $\frac{\cancel{1500}\ 500}{\cancel{27}\ 9}$ = 55.5 yd^3.

$\simeq$ 60 cubic yards.

APPENDIX E

CORRESPONDENCE WITH FDEP

Appendix E-I	CAR Approval Letter
Appendix E-II	RAP Partnering Meeting Minutes

APPENDIX E-I

CAR APPROVAL LETTER

100-7520

Department of Environmental Protection

rec'd 2/14/96

Lawton Chiles
Governor

Twin Towers Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Virginia B. Wetherell
Secretary

February 8, 1996

Mr. Nick Ugolini
Code 184(PVC)
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
P.O. Box 190010
North Charleston, South Carolina 29419-9010

RE: Contamination Assessment Report, Facility 325, Coastal Systems Station Panama City
DEP Facility #035118667

Dear Mr. Ugolini:

The Bureau of Waste Cleanup has reviewed the Contamination Assessment Report (CAR) dated January 1996 (received January 25, 1996), submitted for this site. We found all the documents submitted to date to be adequate to meet the contamination assessment requirements of Rules 62-770.600 and 62-770.630, Florida Administrative Code (F.A.C.). Therefore, you must now submit a Remedial Action Plan (RAP) in accordance with Rule 62-770.700, F.A.C.

The RAP should include remedial actions for free product removal and soil remediation, as well as a plan for monitoring of the groundwater. We suggest the following wells be used for monitoring:

Upgradient Wells	MW-20; MW-25
Source Wells	MW-8; MW-9; MW-10; MW-15; MW-21; MW-23; and MW-26
Perimeter Wells	MW-2; MW-7; MW-12 and MW-14

Please submit the RAP within two (2) months of receipt of this request, as required by Rule 62-770.700(1), F.A.C. If you should have any questions concerning this review, please contact me at (904)921-9989.

Sincerely,

John W. Mitchell

John W. Mitchell
Remedial Project Manager

"Protect, Conserve and Manage Florida's Environment and Natural Resources"

Printed on recycled paper.

cc: B.K. Morin, Navy SouthDiv
Arturo McDonald, Naval CSS Panama City
Craig Benedikt, USEPA Region IV
Tom Moody, FDEP Northwest District
Mark Diblin, ABB Tallahassee

Reviewed by:

T J Bahr

Timothy J. Bahr
Professional Geologist Supervisor
Bureau of Waste Cleanup

TIMOTHY J. BAHR
LICENSE NO. 1209
STATE OF FLORIDA
PROFESSIONAL GEOLOGIST

2/9/96
Date

JJC JJC ESN ESN

APPENDIX E-II

RAP PARTNERING MEETING MINUTES

MEMORANDUM

From: Gopi Kanchibhatla

To: Mark Diblin
cc: Mike Dunaway

Date: March 8, 1996

SUBJECT: **COASTAL SYSTEMS STATION, SITE 325, PANAMA CITY, FLORIDA REMEDIAL ACTION PLAN PARTNERING MEETING**

Attendees:

John Mitchell (FDEP)
Greg Brown (FDEP)
Mike Dunaway (ABB-ES)
Gopi Kanchibhatla (ABB-ES)

Venu:

FDEP, Tallahasse, Florida

Time:

March 8, 1996
10:00 hrs to 10:50 hrs

Meeting Minutes:

Gopi Kanchibhatla, presented a brief description of Site 325, Coastal Systems Station (CSS), Panama City, Florida including, site description, regulatory history and contamination assessment summary.

All the attendees agreed that Site 325 has

- soil that is "excessively contaminated",
- potential pockets of free product,
- groundwater that is contaminated with total VOA, PAHs, total naphthalenes, and TRPH (PAHs and Benzene exceed MOP guidelines, while the rest are below MOP guidelines), and
- the nearest exposure point for groundwater is the St. Andrew Bay which is about 200 ft in the downgradient direction, and the plume is surrounded by a line of monitoring wells which establish that the contamination has not left the site.

Gopi Kanchibhatla, presented the remedial action plan as follows:

- free product monitoring and recovery via vacuum enhanced extraction,
- soil vapor extraction (SVE) for vadose zone contamination,
- hot spot extraction of groundwater, and
- groundwater monitoring.

Greg Brown, suggested use of air sparging along with the SVE and indicated that it would add to the cleanup of groundwater for a fraction of additional cost to the SVE. Also, since the JP-5 release at Site 325 is recent, and soils assessment indicates presence of contaminants closer to the water table, air sparging will enhance removal rates of contaminants from groundwater.

Gopi Kanchibhatla, and Mike Dunaway indicated that a cost and effectiveness analyses will be done for air sparging vs. monitoring only scenario for groundwater before making the decision.

At this time Tim Bahr (FDEP) entered the room and Greg Brown enquired Tim on the policy of FDEP on RBCA (Risk Based Cleanup Action). Tim indicated that FDEP has the policy, and it may be applicable for Site 325. Thus if free product and soil contamination are cleaned, and there are no exposure pathways, groundwater at Site 325 could have a monitoring only plan. ABB-ES, suggested that the RAP will be finalized after comparing the cost, and effectiveness of MOP vs. air sparging.

COST ESTIMATE

```
[illegible]SIC INFORMATION **
00 1  1  15
01 PRELIMINARY
02
03 CSS PANAMA CITY, SITE 325
04
05 PANAMA CITY, FLORIDA
06 N1
07 05/05/96
08 BLAKE SVENDSEN
09    200000.00
10       1.00
11 EA
12 01/21/92
13 02
** PRIME CONTRACTOR MARKUP **
14 A XXXXX  0.0  0.0  0.0  2  2  2  5  5  5 0.00  0.0  5.00   2.0  0.00  6.00  2.00
** SUBCONTRACTOR MARKUP **
15 A XXXXX  0.0 35.0  0.0  2 17  2 10 10 10  5  5  5  5  5  5  1.50  0.0  0.00  0.0  0.00  0.00  0.00
** END ITEMS **
```

WBS	ITEM	QTY	UM	R	SPEC	SSPEC	GRP	MATL	LABR	EQP	DESC
0103	AAAAAA	1.00	SF					0.00	0.00	0.00	SLAB ON GRADE
010301	AAAAAA	1.00	SF					0.00	0.00	0.00	EQUIPMENT COMPOUND PAD
01030101	AAAAAA	1.00	SF					0.00	0.00	0.00	EQUIPMENT COMPOUND PAD
[illegible]30101	CON001	2.00	EA		13900	13900	EC	98.00	97.00	0.00	GATE: 6' BY 5' WOODEN ST OCKADE FENCING GATE
01030101	CON001	115.00	LF		13900	13900	EC	13.00	2.80	0.00	6' PERIMETER STOCKADE FE NCING
01030101	CON001	900.00	SF		13900	13900	EC	2.29	0.61	0.00	30' BY 30' BY 6" EQUIP MENT PAD
01030101	CON002	1.00	EA		13900	13900	EC	0.00	49.62	356.00	SWITCH BOX
01030101	CON002	1.00	LS		13900	13900	EC	580.00	124.00	0.00	ELECTRICAL HOOKUP
01030101	SYSDC	0.00						0.00	0.00	0.00	EQUIPMENT COMPOUND PAD
0806	AAAAAA	1.00	LF					0.00	0.00	0.00	SPECIAL PLUMBING SYSTEMS
080601	AAAAAA	1.00	EA					0.00	0.00	0.00	VACUUM ENHANCED EXTRACTI ON (VEE)
08060101	AAAAAA	1.00	EA					0.00	0.00	0.00	VACUUM ENHANCED EXTRACTI ON (VEE)
08060101	CON001	1.00	EA		13900	13900	TR	110.00	7.50	0.00	VACUUM REGULATOR
08060101	CON001	6.00	EA		13900	13900	PI	155.00	20.00	0.00	LIQUID LEVEL SENSOR
08060101	CON001	14.00	EA		13900	13900	TR	8.27	2.10	0.00	SAMPLING PORT
08060101	CON001	12.00	EA		13900	13900	PI	58.00	20.00	0.00	PRESSURE INDICATOR
08060101	CON001	1.00	EA		13900	13900	PI	580.00	55.00	0.00	TOTALIZER FLOW METER

** END ITEMS **

WBS	ITEM	QTY	UM	R SPEC	SSPEC	GRP	MATL	LABR	EQP	DESC
08060101	CON001	21.00	EA	13900	13900	PI	80.00	12.00	0.00	BALL VALVES
08060101	CON001	20.00	EA	13900	13900	TR	10.20	0.00	0.00	4 IN. DIA. SCH. 80 PVC V ACUUM EXTRACTIO N PIPING
08060101	CON001	10.00	EA	13900	13900	PI	50.00	79.00	0.00	4" BY 4" BY 1" TEE CONNE CTION
08060101	CON001	15.00	EA	13900	13900	PI	50.00	5.20	0.00	CAM AND GROVE COUPLER
08060101	CON001	5.00	EA	13900	13900	PI	235.00	25.00	0.00	WELL FLOW METER (WATER)
08060101	CON001	5.00	EA	13900	13900	PI	1.00	0.00	0.00	FLOW METER (AIR)
08060101	CON001	1750.00	LF	13900	13900	TR	4.60	5.20	0.00	1 IN. SCH. 40 PVC VEE PI PING
08060101	SYSDC	0.00					0.00	0.00	0.00	VACUUM ENHANCED EXTRACTI ON (VEE)
080690	AAAAAA	1.00	EA				0.00	0.00	0.00	AQUIFER AIR SPARGING
08069001	AAAAAA	1.00	EA				0.00	0.00	0.00	AQUIFER AIR SPARGING
08069001	CON001	4.00	EA	13900	13900	PI	58.00	20.00	0.00	PRESSURE INDICATOR
08069001	CON001	4.00	EA	13900	13900	PI	235.00	25.00	0.00	FLOW METER
08069001	CON001	8.00	EA	13900	13900	PI	80.00	12.00	0.00	BALL VALVE
08069001	CON001	21.00	EA	13900	13900	PI	2.80	14.60	0.00	1 IN. SCH. 80 PVC AIR IN JECTION 90 DEG EE ELBOW
08069001	CON001	785.00	LF	13900	13900	TR	4.60	5.20	0.00	1 IN. SCH. 80 PVC AIR IN JECTION PIPING
08069001	SYSDC	0.00					0.00	0.00	0.00	AQUIFER AIR SPARGING
3301	AAAAAA	1.00	LS				0.00	0.00	0.00	MOBILIZATION AND PREPARA TORY WORK
330101	AAAAAA	1.00	LS				0.00	0.00	0.00	MOBILIZATION OF CONSTRUC TION EQIPMENT
33010101	AAAAAA	1.00	LS				0.00	0.00	0.00	MOBILIZATION OF EQUIPMEN T AND DRILLER P ROCUREMEN T
33010101	CON001	1.00	LS	13900	13900	MB	0.00	2200.00	0.00	MOBILIZATION OF EQUIPMEN T AND DRILLER P ROCUREMEN T
33010101	SYSDC	0.00					0.00	0.00	0.00	MOBILIZATION OF CONSTRUC TION EQUIPMENT
330102	AAAAAA	1.00	LS				0.00	0.00	0.00	MOBILIZATION OF PERSONNE L
33010201	CON001	1.00	LS	13900	13900	MB	0.00	1000.00	0.00	MOBILIZATION OF PERSONNE L
330103	AAAAAA	1.00	LS				0.00	0.00	0.00	PRECONSTRUCTION PERMITTI NG
33010301	AAAAAA	1.00	EA				0.00	0.00	0.00	PERMITTING
33010301	CON001	1.00	EA	13900	13900	MB	0.00	850.00	0.00	PERMIT AQUISITION

ND ITEMS **

WBS	ITEM	QTY	UM	R	SPEC	SSPEC	GRP	MATL	LABR	EQP	DESC
33010301	SYSDC	0.00						0.00	0.00	0.00	PERMITTING
3303	AAAAAA	1.00	LS					0.00	0.00	0.00	WELL DRILLING, TRENCHING , AND PIPING
330303	AAAAAA	1.00	LF					0.00	0.00	0.00	TRENCHING AND PIPING
33030301	AAAAAA	1.00	LF					0.00	0.00	0.00	TRENCHING
33030301	CON001	120.00	SF		13900	13900	TR	0.00	3.80	0.00	PAVEMENT DISPOSAL
33030301	CON001	120.00	LF		13900	13900	TR	0.00	2.56	0.00	PAVEMENT CUTTING
33030301	CON001	390.00	LF		13900	13900	TR	1.80	0.00	0.00	TRENCH EXCAVATION AND BA CKFILL
33030301	CON001	1.00	LS		13900	13900	TR	0.00	1500.00	450.00	UTILITY LOCATION SURVEY
33030301	CON001	1.00	LS		13900	13900	TR	1.00	0.00	0.00	CONTAMINATED SOIL DISPOS AL FROM TRENCHE S
33030301	CON001	2940.00	LF		13900	13900	TR	1.00	0.00	0.00	PIPING INSTALLATION
33030301	CON001	1.00	LS		13900	13900	TR	1.00	0.00	0.00	ONSITE CONTAMINATED SOIL TEMPORARY STOR AGE
33030301	SYSDC	0.00						0.00	0.00	0.00	TRENCHING
330390	AAAAAA	1.00	LF					0.00	0.00	0.00	WELL DRILLING
39001	CON003	14.00	LF		13900	13900	WD	7.00	0.00	0.00	BENTONITE SEAL IN WELLS
33039001	CON003	7.00	LS		13900	13900	WD	500.00	0.00	0.00	INVESTIGATIVE WASTE DISP OSAL
33039001	CON003	120.00	LF		13900	13900	WD	12.00	0.00	0.00	SAND PACK FOR WELLS
33039001	CON003	150.00	LF		13900	13900	WD	28.00	0.00	0.00	HALLOW STEM AUGER BORE H OLE ADVANCEMENT
33039001	CON003	100.00	LF		13900	13900	WD	5.00	0.00	0.00	GROUT INSTALLATION IN WE LLS
33039001	CON003	1.00	LS		13900	13900	WD	0.00	0.00	2400.00	DRILLIER MOBIOIZATION
330391	AAAAAA	1.00	LS					0.00	0.00	0.00	CLAY LINER AND SITE REPA IR
33039101	AAAAAA	1.00	LF					0.00	0.00	0.00	SITE REPAIR
33039101	CON001	2.00	LOT		13900	13900	DM	150.00	0.00	0.00	SOD AND GRASS SEEDING
33039101	CON001	150.00	SY		13900	13900	TR	8.30	4.62	1.34	CLAY LINER, 2' THICK FOR VEE AND AAS
33039101	SYSDC	0.00						0.00	0.00	0.00	SITE REPAIR AND DEMOBILI ZATION
330392	AAAAAA	1.00	YR					0.00	0.00	0.00	SYSTEM OPERATION, MAINTA NENCE, SAMPLING AND REPO RTING
33039201	AAAAAA	1.00	YR					0.00	0.00	0.00	SYSTEM OPERATION, MAINTA NENCE, SAMPLING AND REPO RTING

** END ITEMS **

WBS	ITEM	QTY	UM	R	SPEC	SSPEC	GRP	MATL	LABR	EQP	DESC
33039201	ABB001	4.00	PRD		13900	13900	OM	2200.00	6800.00	2100.00	SAMPLING/ANALYTICAL AND REPORTING FOR O NE YEAR I N 4 PERIODS
33039201	CON001	52.00	WKS		13900	13900	OM	0.00	250.00	0.00	INSPECTION AND VISIT COS T PER YEAR
33039201	CON001	1.00	YR		13900	13900	OM	7800.00	0.00	0.00	POWER COSTS FOR ONE YEAR
33039201	SYSDC	0.00						0.00	0.00	0.00	SYSTEM OPERATION, MAINTA NENCE, SAMPLING , AND REP ORTING
3313	AAAAAA	1.00	EA					0.00	0.00	0.00	SITE EQUIPMENT
331325	AAAAAA	1.00	EA					0.00	0.00	0.00	VEE AND AAS SYSTEMS
33132501	AAAAAA	1.00	EA					0.00	0.00	0.00	VACUUM ENHANCED EXTRACTI ON
33132501	CON001	1.00	EA		13900	13900	EQ	0.00	0.00	9850.00	LIQUID RING PUMP SYSTEM
33132501	CON001	1.00	EA		13900	13900		0.00	0.00	3200.00	LIQUID RING PUMP CONTROL ER
33132501	CON001	1.00	EA		13900	13900	EQ	0.00	0.00	1800.00	DUAL PHASE EXTRACTION
33132501	CON001	1.00	EA		13900	13900	EQ	0.00	0.00	3400.00	AIR COOLED HEAT EXCHANGE R
33132501	CON001	1.00	EA		13900	13900	EQ	0.00	0.00	1620.00	POLYETHYLENE SKID MOUNTE D STORAGE TANKS
33132501	CON001	25.00	LF		13900	13900	EQ	4.52	8.80	0.00	STORAGE TANK DISCHARGE P IPING
33132501	CON001	1.00	EA		13900	13900	EQ	0.00	0.00	720.00	DEMISTING PAD
33132501	CON001	8.00	MO		13900	13900	EQ	4000.00	0.00	0.00	CARBON REPLACEMENT
33132501	CON001	2.00	EA		13900	13900	PI	6500.00	0.00	0.00	CARBON CANISTERS
33132501	SYSDC	0.00						0.00	0.00	0.00	VACUUM ENHANCED EXTRACTI ON
33132502	AAAAAA	1.00	EA					0.00	0.00	0.00	AQUIFER AIR SPARGING
33132502	CON001	1.00	EA		13900	13900	EQ	0.00	0.00	6500.00	AIR SPARGING SYSTEM
33132502	SYSDC	0.00						0.00	0.00	0.00	AQUIFER AIR SPARGING
GRP	AAAAAA	0.00					DM	0.00	0.00	0.00	DE-MOBILIZATION
GRP	AAAAAA	0.00					EC	0.00	0.00	0.00	EQUIPMENT COMPOUND
GRP	AAAAAA	0.00					EQ	0.00	0.00	0.00	EQUIPMENT
GRP	AAAAAA	0.00					MB	0.00	0.00	0.00	MOBILIZATION
GRP	AAAAAA	0.00					OM	0.00	0.00	0.00	OPERATION AND MAINTANENC E
GRP	AAAAAA	0.00					TR	0.00	0.00	0.00	TRENCHING AND PIPING

SUMMARY REPORT
WORK BREAKDOWN
PRELIMINARY

PRINTING DATE	: 05/16/96 15
DATABASE USED	: 01/21/92 02
PAGE NUMBER	: 1
ESTIMATE NAME	: CSS325

ENGINEERING ESTIMATE

PROJECT: CSS PANAMA CITY, SITE 325
LOCATION: PANAMA CITY, FLORIDA
ESTIMATORS: BLAKE SVENDSEN
PROJECT SIZE: 1.00 EA
AUTHORIZED CONSTRUCTION FUNDS: 200,000.00

CAT CODE:
UIC: N1
P-NO.:
DATE OF ESTIMATE: 05/16/96
BID DATE: 05/05/96

	COST/ WBS BASED ON 1.00	WBS UNITS	U/M	COST/WBS UNIT	TOTAL MU MATL COST	TOTAL MU LABOR COST	TOTAL MU EQUIP COST	TOTAL CONTRACT COST
PRIMARY FACILITIES								
0103 SLAB ON GRADE	8,083.91	1.00	SF	8,083.91	5,909	1,689	486	8,084
0806 SPECIAL PLUMBING SYSTEMS	48,748.11	1.00	LF	48,748.11	27,659	21,089	0	48,748
SUBTOTAL PRIMARY FACILITIES	56,832.02				33,567	22,779	486	56,832
ENVIRONMENTAL								
3301 MOBILIZATION AND PREPARA								
01 MOBILIZATION OF CONSTRUC		1.00	LS	3,000.80	0	3,001	0	3,001
02 MOBILIZATION OF PERSONNE		1.00	LS	1,364.00	0	1,364	0	1,364
03 PRECONSTRUCTION PERMITTI		1.00	LS	1,159.40	0	1,159	0	1,159
3303 WELL DRILLING, TRENCHING								
[illegible]3 TRENCHING AND PIPING		1.00	LF	8,671.22	4,970	3,087	614	8,671
[illegible]0 WELL DRILLING		1.00	LF	16,556.23	13,283	0	3,274	16,556
91 CLAY LINER AND SITE REPA		1.00	LS	3,326.79	2,107	945	274	3,327
92 SYSTEM OPERATION, MAINTA		1.00	YR	88,932.80	22,642	54,833	11,458	88,933
3313 SITE EQUIPMENT								
25 VEE AND AAS SYSTEMS		1.00	EA	98,784.97	61,534	300	36,951	98,785
SUBTOTAL ENVIRONMENTAL					104,537	64,689	52,570	221,796
TOTAL ESTIMATE CONTRACT					138,104	87,468	53,056	278,628
TOTAL ESTIMATE CONTRACT (ROUNDED)								279,000

INPUT REPORT
MARK-UP
PRELIMINARY

PRINTING DATE : 05/16/96 15
DATABASE USED : 01/21/92 02
PAGE NUMBER : 1
ESTIMATE NAME : CSS325

ENGINEERING ESTIMATE

PROJECT: CSS PANAMA CITY, SITE 325
LOCATION: PANAMA CITY, FLORIDA
ESTIMATORS: BLAKE SVENDSEN
PROJECT SIZE: 1.00 EA
AUTHORIZED CONSTRUCTION FUNDS: 200,000.00

CAT CODE:
UIC: N1
P-NO.:
DATE OF ESTIMATE: 05/16/96
BID DATE: 05/05/96

PRIME MARK-UP

SPECIFICATION SECTIONS
MARKED UP FOR PRIME
XXXXX

DESIGN CONTINGENCIES	10.00%		
TAX ON MATERIAL	0.0%		
TAX & INSURANCE ON LABOR	0.0%		
TAX ON EQUIPMENT	0.0%		
PRIME OVERHEAD	MAT'L	LABOR	EQUIP
	2%	2%	2%
PRIME PROFIT	MAT'L	LABOR	EQUIP
	5%	5%	5%
BOND	0.00%		
MISC. TAXES	0.0%		
CQC	5.00%		
ESCALATION	2.0%		
PCAS	0.00%		
CONT	6.00%		
SIOH	2.00%		
MATERIAL COMPOSITE MARK-UP	1.364		
LABOR COMPOSITE MARK-UP	1.364		
EQUIPMENT COMPOSITE MARK-UP	1.364		

SUB MARK-UP A

SPECIFICATION SECTIONS
MARKED UP FOR SUB
XXXXX

DESIGN CONTINGENCIES	0.00%		
TAX ON MATERIAL	0.0%		
TAX & INSURANCE ON LABOR	35.0%		
TAX ON EQUIPMENT	0.0%		
SUB OVERHEAD	MAT'L	LABOR	EQUIP
	2%	17%	2%
SUB PROFIT	MAT'L	LABOR	EQUIP
	10%	10%	10%
PRIME OVERHEAD	MAT'L	LABOR	EQUIP
	5%	5%	5%
PRIME PROFIT	MAT'L	LABOR	EQUIP
	5%	5%	5%
BOND	1.50%		
MISC. TAXES	0.0%		
CQC	0.00%		
ESCALATION	0.0%		
PCAS	0.00%		
CONT	0.00%		
SIOH	0.00%		
MATERIAL COMPOSITE MARK-UP	1.256		
LABOR COMPOSITE MARK-UP	1.944		
EQUIPMENT COMPOSITE MARK-UP	1.256		

INPUT REPORT
MODIFIER
PRELIMINARY

PRINTING DATE : 05/16/96 15
DATABASE USED : 01/21/92 02
PAGE NUMBER : 1
ESTIMATE NAME : CSS325

ENGINEERING ESTIMATE

PROJECT: CSS PANAMA CITY, SITE 325
LOCATION: PANAMA CITY, FLORIDA
ESTIMATORS: BLAKE SVENDSEN
PROJECT SIZE: 1.00 EA
AUTHORIZED CONSTRUCTION FUNDS: 200,000.00

CAT CODE:
UIC: N1
P-NO.:
DATE OF ESTIMATE: 05/16/96
BID DATE: 05/05/96

SPEC	ACT	WBS	MATL	LABOR	EQUIP

BACKUP REPORT
WORK BREAKDOWN-SPEC
PRELIMINARY

PRINTING DATE : 05/16/96 15
DATABASE USED : 01/21/92 02
PAGE NUMBER : 1
ESTIMATE NAME : CSS325

ENGINEERING ESTIMATE

PROJECT: CSS PANAMA CITY, SITE 325
LOCATION: PANAMA CITY, FLORIDA
ESTIMATORS: BLAKE SVENDSEN
PROJECT SIZE: 1.00 EA
AUTHORIZED CONSTRUCTION FUNDS: 200,000.00

CAT CODE:
UIC: N1
P-NO.:
DATE OF ESTIMATE: 05/16/96
BID DATE: 05/05/96

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
01030101 SUBSTRUCTURE						
SLAB ON GRADE						
STANDARD SLAB ON GRADE						
EQUIPMENT COMPOUND PAD						
SYSDC EQUIPMENT COMPOUND PAD						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001 GATE: 6' BY 5' WOODEN ST			133.67*	132.31*	0.00*	265.98
OCKADE FENCING GATE	2.00	EA	267	265	0	532
CON001 6' PERIMETER STOCKADE FE			17.73*	3.82*	0.00*	21.55
NCING	115.00	LF	2,039	439	0	2,478
CON001 30' BY 30' BY 6" EQUIP			3.12*	0.83*	0.00*	3.96
MENT PAD	900.00	SF	2,811	749	0	3,560
CON002			0.00*	67.68*	485.58*	553.27
SWITCH BOX	1.00	EA	0	68	486	553
CON002			791.12*	169.14*	0.00*	960.26
ELECTRICAL HOOKUP	1.00	LS	791	169	0	960
SUBTOTAL-SUBSPEC SECTION 13900			5,909	1,689	486	8,084
TOTAL FOR SPEC SECTION 13900			5,909	1,689	486	8,084
SUBTOTAL-WORK BREAKDOWN 01030101			5,909	1,689	486	8,084
TOTAL FOR WORK BREAKDOWN 01030101			5,909	1,689	486	8,084
COST/WBS UNIT 01030101						8,083.91

++

08060101 PLUMBING
SPECIAL PLUMBING SYSTEMS
SPECIAL PIPING SYSTEMS
VACUUM ENHANCED EXTRACTI ON (VEE)

SYSDC VACUUM ENHANCED EXTRACTION (VEE)

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
08060101 PLUMBING						
SPECIAL PLUMBING SYSTEMS						
SPECIAL PIPING SYSTEMS						
VACUUM ENHANCED EXTRACTI ON (VEE)						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001			150.04*	10.23*	0.00*	160.27
VACUUM REGULATOR	1.00	EA	150	10	0	160
CON001			211.42*	27.28*	0.00*	238.70
LIQUID LEVEL SENSOR	6.00	EA	1,269	164	0	1,432
CON001			11.28*	2.86*	0.00*	14.14
SAMPLING PORT	14.00	EA	158	40	0	198
CON001			79.11*	27.28*	0.00*	106.39
PRESSURE INDICATOR	12.00	EA	949	327	0	1,277
CON001			791.12*	75.02*	0.00*	866.14
TOTALIZER FLOW METER	1.00	EA	791	75	0	866
CON001			109.12*	16.37*	0.00*	125.49
BALL VALVES	21.00	EA	2,292	344	0	2,635
CON001 4 IN. DIA. SCH. 80 PVC V			13.91*	0.00*	0.00*	13.91
ACUUM EXTRACTION PIPING	20.00	EA	278	0	0	278
CON001 4" BY 4" BY 1" TEE CONNE			68.20*	107.76*	0.00*	175.96
CTION	10.00	EA	682	1,078	0	1,760
N001			68.20*	7.09*	0.00*	75.29
CAM AND GROVE COUPLER	15.00	EA	1,023	106	0	1,129
CON001			320.54*	34.10*	0.00*	354.64
WELL FLOW METER (WATER)	5.00	EA	1,603	171	0	1,773
CON001			1.36*	0.00*	0.00*	1.36
FLOW METER (AIR)	5.00	EA	7	0	0	7
CON001 1 IN. SCH. 40 PVC VEE PI			6.27*	7.09*	0.00*	13.37
PING	1,750.00	LF	10,980	12,412	0	23,393
SUBTOTAL-SUBSPEC SECTION 13900			20,181	14,727	0	34,908
TOTAL FOR SPEC SECTION 13900			20,181	14,727	0	34,908
SUBTOTAL-WORK BREAKDOWN 08060101			20,181	14,727	0	34,908
TOTAL FOR WORK BREAKDOWN 08060101			20,181	14,727	0	34,908
COST/WBS UNIT 08060101						34,908.42

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08069001 PLUMBING
SPECIAL PLUMBING SYSTEMS

SYSDC AQUIFER AIR SPARGING

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
08069001 PLUMBING						
SPECIAL PLUMBING SYSTEMS						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001			79.11*	27.28*	0.00*	106.39
PRESSURE INDICATOR	4.00	EA	316	109	0	426
CON001			320.54*	34.10*	0.00*	354.64
FLOW METER	4.00	EA	1,282	136	0	1,419
CON001			109.12*	16.37*	0.00*	125.49
BALL VALVE	8.00	EA	873	131	0	1,004
CON001 1 IN. SCH. 80 PVC AIR IN			3.82*	19.91*	0.00*	23.73
JECTION 90 DEGREE ELBOW	21.00	EA	80	418	0	498
CON001 1 IN. SCH. 80 PVC AIR IN			6.27*	7.09*	0.00*	13.37
JECTION PIPING	785.00	LF	4,925	5,568	0	10,493
SUBTOTAL-SUBSPEC SECTION 13900			7,477	6,363	0	13,840
TOTAL FOR SPEC SECTION 13900			7,477	6,363	0	13,840
SUBTOTAL-WORK BREAKDOWN 08069001			7,477	6,363	0	13,840
TOTAL FOR WORK BREAKDOWN 08069001			7,477	6,363	0	13,840
COST/WBS UNIT 08069001						13,839.69

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	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33010101 HTRW REMEDIAL ACTION						
MOBILIZATION AND PREPARATORY WORK						
MOBILIZATION OF CONSTRUCTION EQP AND FACILITIES						
MOBILIZATION OF EQUIPMEN T AND DRILLER PROCUREMEN T						
SYSDC MOBILIZATION OF CONSTRUCTION EQUIPMENT						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001 MOBILIZATION OF EQUIPMEN						
T AND DRILLER PROCUREMEN			0.00*	3,000.80*	0.00*	3,000.80
T	1.00	LS	0	3,001	0	3,001
SUBTOTAL-SUBSPEC SECTION 13900			0	3,001	0	3,001
TOTAL FOR SPEC SECTION 13900			0	3,001	0	3,001
SUBTOTAL-WORK BREAKDOWN 33010101			0	3,001	0	3,001
TOTAL FOR WORK BREAKDOWN 33010101			0	3,001	0	3,001
COST/WBS UNIT 33010101						3,000.80

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	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33010201 HTRW REMEDIAL ACTION						
MOBILIZATION AND PREPARATORY WORK						
MOBILIZATION OF PERSONNEL						
MOBILIZATION OF PERSONNE L						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001 MOBILIZATION OF PERSONNE			0.00*	1,364.00*	0.00*	1,364.00
L	1.00	LS	0	1,364	0	1,364
SUBTOTAL-SUBSPEC SECTION 13900			0	1,364	0	1,364
TOTAL FOR SPEC SECTION 13900			0	1,364	0	1,364
SUBTOTAL-WORK BREAKDOWN 33010201			0	1,364	0	1,364
TOTAL FOR WORK BREAKDOWN 33010201			0	1,364	0	1,364
COST/WBS UNIT 33010201						1,364.00

++

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33010301 HTRW REMEDIAL ACTION						
MOBILIZATION AND PREPARATORY WORK						
PRECONSTRUCTION SUBMITTALS/IMPLEMENTATION PLANS						
PERMITTING						
SDC PERMITTING						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001			0.00*	1,159.40*	0.00*	1,159.40
PERMIT AQUISITION	1.00	EA	0	1,159	0	1,159
SUBTOTAL-SUBSPEC SECTION 13900			0	1,159	0	1,159
TOTAL FOR SPEC SECTION 13900			0	1,159	0	1,159
SUBTOTAL-WORK BREAKDOWN 33010301			0	1,159	0	1,159
TOTAL FOR WORK BREAKDOWN 33010301			0	1,159	0	1,159
COST/WBS UNIT 33010301						1,159.40

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33030301 HTRW REMEDIAL ACTION
SITE WORK
EARTHWORK
TRENCHING

SYSDC TRENCHING

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33030301 HTRW REMEDIAL ACTION						
SITE WORK						
EARTHWORK						
TRENCHING						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001			0.00*	5.18*	0.00*	5.18
PAVEMENT DISPOSAL	120.00	SF	0	622	0	622
CON001			0.00*	3.49*	0.00*	3.49
PAVEMENT CUTTING	120.00	LF	0	419	0	419
CON001 TRENCH EXCAVATION AND BA			2.46*	0.00*	0.00*	2.46
CKFILL	390.00	LF	958	0	0	958
CON001			0.00*	2,046.00*	613.80*	2,659.80
UTILITY LOCATION SURVEY	1.00	LS	0	2,046	614	2,660
CON001 CONTAMINATED SOIL DISPOS			1.36*	0.00*	0.00*	1.36
AL FROM TRENCHES	1.00	LS	1	0	0	1
CON001			1.36*	0.00*	0.00*	1.36
PIPING INSTALLATION	2,940.00	LF	4,010	0	0	4,010
CON001 ONSITE CONTAMINATED SOIL			1.36*	0.00*	0.00*	1.36
TEMPORARY STORAGE	1.00	LS	1	0	0	1
SUBTOTAL-SUBSPEC SECTION 13900			4,970	3,087	614	8,671
TOTAL FOR SPEC SECTION 13900			4,970	3,087	614	8,671
SUBTOTAL-WORK BREAKDOWN 33030301			4,970	3,087	614	8,671
TOTAL FOR WORK BREAKDOWN 33030301			4,970	3,087	614	8,671
COST/WBS UNIT 33030301						8,671.22

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	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33039001 HTRW REMEDIAL ACTION						
SITE WORK						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON003			9.55*	0.00*	0.00*	9.55
BENTONITE SEAL IN WELLS	14.00	LF	134	0	0	134
CON003 INVESTIGATIVE WASTE DISP			682.00*	0.00*	0.00*	682.00
OSAL	7.00	LS	4,774	0	0	4,774
CON003			16.37*	0.00*	0.00*	16.37
SAND PACK FOR WELLS	120.00	LF	1,964	0	0	1,964
CON003 HALLOW STEM AUGER BORE H			38.19*	0.00*	0.00*	38.19
OLE ADVANCEMENT	150.00	LF	5,729	0	0	5,729

BACKUP REPORT
WORK BREAKDOWN-SPEC

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33039001 HTRW REMEDIAL ACTION						
SITE WORK						
CON003 GROUT INSTALLATION IN WE			6.82*	0.00*	0.00*	6.82
LLS	100.00	LF	682	0	0	682
CON003			0.00*	0.00*	3,273.60*	3,273.60
DRILLIER MOBIOIZATION	1.00	LS	0	0	3,274	3,274
SUBTOTAL-SUBSPEC SECTION 13900			13,283	0	3,274	16,556
TOTAL FOR SPEC SECTION 13900			13,283	0	3,274	16,556
SUBTOTAL-WORK BREAKDOWN 33039001			13,283	0	3,274	16,556
TOTAL FOR WORK BREAKDOWN 33039001			13,283	0	3,274	16,556
COST/WBS UNIT 33039001						16,556.23

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	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33039101 HTRW REMEDIAL ACTION						
SITE WORK						
SYSDC SITE REPAIR AND DEMOBILIZATION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001			204.60*	0.00*	0.00*	204.60
SOD AND GRASS SEEDING	2.00	LOT	409	0	0	409
CON001 CLAY LINER, 2' THICK FOR			11.32*	6.30*	1.83*	19.45
VEE AND AAS	150.00	SY	1,698	945	274	2,918
SUBTOTAL-SUBSPEC SECTION 13900			2,107	945	274	3,327
TOTAL FOR SPEC SECTION 13900			2,107	945	274	3,327
SUBTOTAL-WORK BREAKDOWN 33039101			2,107	945	274	3,327
TOTAL FOR WORK BREAKDOWN 33039101			2,107	945	274	3,327
COST/WBS UNIT 33039101						3,326.80

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	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33039201 HTRW REMEDIAL ACTION						
SITE WORK						
SYSDC SYSTEM OPERATION, MAINTANENCE, SAMPLING, AND REPORTING						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
ABB001 SAMPLING/ANALYTICAL AND						
REPORTING FOR ONE YEAR I			3,000.80*	9,275.20*	2,864.40*	15,140.40
N 4 PERIODS	4.00	PRD	12,003	37,101	11,458	60,562

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33039201 HTRW REMEDIAL ACTION						
SITE WORK						
CON001 INSPECTION AND VISIT COS			0.00*	341.00*	0.00*	341.00
T PER YEAR	52.00	WKS	0	17,732	0	17,732
CON001			10,639.20*	0.00*	0.00*	10,639.20
POWER COSTS FOR ONE YEAR	1.00	YR	10,639	0	0	10,639
SUBTOTAL-SUBSPEC SECTION 13900			22,642	54,833	11,458	88,933
TOTAL FOR SPEC SECTION 13900			22,642	54,833	11,458	88,933
SUBTOTAL-WORK BREAKDOWN 33039201			22,642	54,833	11,458	88,933
TOTAL FOR WORK BREAKDOWN 33039201			22,642	54,833	11,458	88,933
COST/WBS UNIT 33039201						88,932.80

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	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
33132501 HTRW REMEDIAL ACTION						
PHYSICAL TREATMENT						
AERATION						
VACUUM ENHANCED EXTRACTI ON						
SYSDC VACUUM ENHANCED EXTRACTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
13900 MISCELLANEOUS SPECIAL CONSTRUCTION						
CON001			0.00*	0.00*	13,435.40*	13,435.40
LIQUID RING PUMP SYSTEM	1.00	EA	0	0	13,435	13,435
CON001 LIQUID RING PUMP CONTROL			0.00*	0.00*	4,364.80*	4,364.80
ER	1.00	EA	0	0	4,365	4,365
CON001			0.00*	0.00*	2,455.20*	2,455.20
DUAL PHASE EXTRACTION	1.00	EA	0	0	2,455	2,455
CON001 AIR COOLED HEAT EXCHANGE			0.00*	0.00*	4,637.60*	4,637.60
R	1.00	EA	0	0	4,638	4,638
CON001 POLYETHYLENE SKID MOUNTE			0.00*	0.00*	2,209.68*	2,209.68
D STORAGE TANKS	1.00	EA	0	0	2,210	2,210
CON001 STORAGE TANK DISCHARGE P			6.17*	12.00*	0.00*	18.17
IPING	25.00	LF	154	300	0	454
CON001			0.00*	0.00*	982.08*	982.08
DEMISTING PAD	1.00	EA	0	0	982	982
CON001			5,456.00*	0.00*	0.00*	5,456.00
CARBON REPLACEMENT	8.00	MO	43,648	0	0	43,648
CON001			8,866.00*	0.00*	0.00*	8,866.00
CARBON CANISTERS	2.00	EA	17,732	0	0	17,732
SUBTOTAL-SUBSPEC SECTION 13900			61,534	300	28,085	89,919
TOTAL FOR SPEC SECTION 13900			61,534	300	28,085	89,919
SUBTOTAL-WORK BREAKDOWN 33132501			61,534	300	28,085	89,919

		QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
TOTAL FOR WORK BREAKDOWN	33132501			61,534	300	28,085	89,919
COST/WBS UNIT	33132501						89,918.97

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33132502 HTRW REMEDIAL ACTION
PHYSICAL TREATMENT
AERATION
AQUIFER AIR SPARGING

SYSDC AQUIFER AIR SPARGING

13900 MISCELLANEOUS SPECIAL CONSTRUCTION

		QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
13900 MISCELLANEOUS SPECIAL CONSTRUCTION							
CON001				0.00*	0.00*	8,866.00*	8,866.00
AIR SPARGING SYSTEM		1.00	EA	0	0	8,866	8,866
SUBTOTAL-SUBSPEC SECTION	13900			0	0	8,866	8,866
TOTAL FOR SPEC SECTION	13900			0	0	8,866	8,866
SUBTOTAL-WORK BREAKDOWN	33132502			0	0	8,866	8,866
TOTAL FOR WORK BREAKDOWN	33132502			0	0	8,866	8,866
COST/WBS UNIT	33132502						8,866.00

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SUMMARY REPORT:
SPEC SECTION
PRELIMINARY

PRINTING DATE : 05/16/96 15
DATABASE USED : 01/21/92 02
PAGE NUMBER : 1
ESTIMATE NAME : CSS325

ENGINEERING ESTIMATE

PROJECT: CSS PANAMA CITY, SITE 325
LOCATION: PANAMA CITY, FLORIDA
ESTIMATORS: BLAKE SVENDSEN
PROJECT SIZE: 1.00 EA
AUTHORIZED CONSTRUCTION FUNDS: 200,000.00

CAT CODE:
UIC: N1
P-NO.:
DATE OF ESTIMATE: 05/16/96
BID DATE: 05/05/96

	MATERIAL		LABOR		EQUIPMENT		
	SUB SPEC SECT	SPEC SECT	SUB SPEC SECT	SPEC SECT	SUB SPEC SECT	SPEC SECT	SPEC SECT
13900 MISCELLANEOUS SPECIAL CONSTRUCTION							
13900 MISCELLANEOUS SPECIAL CONSTRUCTION	138,104		87,468		53,056		
SUBTOTAL SPEC SECTION 13900		138,104		87,468		53,056	278,628
SUBTOTAL SPEC DIVISION 13		138,104		87,468		53,056	278,628
TOTAL		138,104		87,468		53,056	278,628

BACKUP REPORT:
GROUPS
MINARY

PRINTING DATE : 05/16/96 15
DATABASE USED : 01/21/92 02
PAGE NUMBER : 1
ESTIMATE NAME : CSS325

ENGINEERING ESTIMATE

PROJECT: CSS PANAMA CITY, SITE 325
LOCATION: PANAMA CITY, FLORIDA
ESTIMATORS: BLAKE SVENDSEN
PROJECT SIZE: 1.00 EA
AUTHORIZED CONSTRUCTION FUNDS: 200,000.00

CAT CODE:
UIC: N1
P-NO.:
DATE OF ESTIMATE: 05/16/96
BID DATE: 05/05/96

		QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
DM DE-MOBILIZATION							
CON001				150.00*	0.00*	0.00*	150.00
	SOD AND GRASS SEEDING	2.00	LOT	300	0	0	300
SUBTOTAL-GROUP	DM			300	0	0	300
TOTAL FOR GROUP	DM			409	0	0	409
TOTAL INCL OVERHEAD	DM			409	0	0	409

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		QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
EC EQUIPMENT COMPOUND							
CON001	GATE: 6' BY 5' WOODEN ST			98.00*	97.00*	0.00*	195.00
	OCKADE FENCING GATE	2.00	EA	196	194	0	390
CON001	6' PERIMETER STOCKADE FE			13.00*	2.80*	0.00*	15.80
	NCING	115.00	LF	1,495	322	0	1,817
CON001	30' BY 30' BY 6" EQUIP			2.29*	0.61*	0.00*	2.90
	MENT PAD	900.00	SF	2,061	549	0	2,610
CON002				0.00*	49.62*	356.00*	405.62
	SWITCH BOX	1.00	EA	0	50	356	406
CON002				580.00*	124.00*	0.00*	704.00
	ELECTRICAL HOOKUP	1.00	LS	580	124	0	704
SUBTOTAL-GROUP	EC			4,332	1,239	356	5,927
TOTAL FOR GROUP	EC			5,909	1,689	486	8,084
TOTAL INCL OVERHEAD	EC			5,909	1,689	486	8,084

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		QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
EQ EQUIPMENT							
CON001				0.00*	0.00*	9,850.00*	9,850.00
	LIQUID RING PUMP SYSTEM	1.00	EA	0	0	9,850	9,850
CON001				0.00*	0.00*	1,800.00*	1,800.00
	DUAL PHASE EXTRACTION	1.00	EA	0	0	1,800	1,800
CON001	AIR COOLED HEAT EXCHANGE			0.00*	0.00*	3,400.00*	3,400.00
	R	1.00	EA	0	0	3,400	3,400
CON001				0.00*	0.00*	6,500.00*	6,500.00
	AIR SPARGING SYSTEM	1.00	EA	0	0	6,500	6,500

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
CON001 POLYETHYLENE SKID MOUNTE			0.00*	0.00*	1,620.00*	1,620.00
D STORAGE TANKS	1.00	EA	0	0	1,620	1,620
CON001 STORAGE TANK DISCHARGE P			4.52*	8.80*	0.00*	13.32
IPING	25.00	LF	113	220	0	333
CON001			0.00*	0.00*	720.00*	720.00
DEMISTING PAD	1.00	EA	0	0	720	720
CON001			4,000.00*	0.00*	0.00*	4,000.00
CARBON REPLACEMENT	8.00	MO	32,000	0	0	32,000
SUBTOTAL-GROUP EQ			32,113	220	23,890	56,223
TOTAL FOR GROUP EQ			43,802	300	32,586	76,688
TOTAL INCL OVERHEAD EQ			43,802	300	32,586	76,688

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MB MOBILIZATION

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
CON001 MOBILIZATION OF EQUIPMEN						
T AND DRILLER PROCUREMEN			0.00*	2,200.00*	0.00*	2,200.00
T	1.00	LS	0	2,200	0	2,200
CON001 MOBILIZATION OF PERSONNE			0.00*	1,000.00*	0.00*	1,000.00
L	1.00	LS	0	1,000	0	1,000
CON001			0.00*	850.00*	0.00*	850.00
PERMIT AQUISITION	1.00	EA	0	850	0	850
SUBTOTAL-GROUP MB			0	4,050	0	4,050
TOTAL FOR GROUP MB			0	5,524	0	5,524
TOTAL INCL OVERHEAD MB			0	5,524	0	5,524

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OM OPERATION AND MAINTANENC

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
ABB001 SAMPLING/ANALYTICAL AND						
REPORTING FOR ONE YEAR I			2,200.00*	6,800.00*	2,100.00*	11,100.00
N 4 PERIODS	4.00	PRD	8,800	27,200	8,400	44,400
CON001 INSPECTION AND VISIT COS			0.00*	250.00*	0.00*	250.00
T PER YEAR	52.00	WKS	0	13,000	0	13,000
CON001			7,800.00*	0.00*	0.00*	7,800.00
POWER COSTS FOR ONE YEAR	1.00	YR	7,800	0	0	7,800
SUBTOTAL-GROUP OM			16,600	40,200	8,400	65,200
TOTAL FOR GROUP OM			22,642	54,833	11,458	88,933
TOTAL INCL OVERHEAD OM			22,642	54,833	11,458	88,933

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PI OPERATION AND MAINTANENC

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
CON001			155.00*	20.00*	0.00*	175.00
LIQUID LEVEL SENSOR	6.00	EA	930	120	0	1,050

		QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
CON001				58.00*	20.00*	0.00*	78.00
	PRESSURE INDICATOR	12.00	EA	696	240	0	936
CON001				58.00*	20.00*	0.00*	78.00
	PRESSURE INDICATOR	4.00	EA	232	80	0	312
CON001				580.00*	55.00*	0.00*	635.00
	TOTALIZER FLOW METER	1.00	EA	580	55	0	635
CON001				235.00*	25.00*	0.00*	260.00
	FLOW METER	4.00	EA	940	100	0	1,040
CON001				80.00*	12.00*	0.00*	92.00
	BALL VALVES	21.00	EA	1,680	252	0	1,932
CON001				80.00*	12.00*	0.00*	92.00
	BALL VALVE	8.00	EA	640	96	0	736
CON001	4" BY 4" BY 1" TEE CONNE			50.00*	79.00*	0.00*	129.00
	CTION	10.00	EA	500	790	0	1,290
CON001				50.00*	5.20*	0.00*	55.20
	CAM AND GROVE COUPLER	15.00	EA	750	78	0	828
CON001				235.00*	25.00*	0.00*	260.00
	WELL FLOW METER (WATER)	5.00	EA	1,175	125	0	1,300
CON001				1.00*	0.00*	0.00*	1.00
	FLOW METER (AIR)	5.00	EA	5	0	0	5
CON001	1 IN. SCH. 80 PVC AIR IN			2.80*	14.60*	0.00*	17.40
	JECTION 90 DEGREE ELBOW	21.00	EA	59	307	0	365
CON001				6,500.00*	0.00*	0.00*	6,500.00
	CARBON CANISTERS	2.00	EA	13,000	0	0	13,000
	SUBTOTAL-GROUP PI			21,187	2,243	0	23,429
	TOTAL FOR GROUP PI			28,899	3,059	0	31,958
	TOTAL INCL OVERHEAD PI			28,899	3,059	0	31,958

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TR TRENCHING AND PIPING

		QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
CON001				110.00*	7.50*	0.00*	117.50
	VACUUM REGULATOR	1.00	EA	110	8	0	118
CON001				8.27*	2.10*	0.00*	10.37
	SAMPLING PORT	14.00	EA	116	29	0	145
CON001				0.00*	3.80*	0.00*	3.80
	PAVEMENT DISPOSAL	120.00	SF	0	456	0	456
CON001				0.00*	2.56*	0.00*	2.56
	PAVEMENT CUTTING	120.00	LF	0	307	0	307
CON001	TRENCH EXCAVATION AND BA			1.80*	0.00*	0.00*	1.80
	CKFILL	390.00	LF	702	0	0	702
CON001	4 IN. DIA. SCH. 80 PVC V			10.20*	0.00*	0.00*	10.20
	ACUUM EXTRACTION PIPING	20.00	EA	204	0	0	204
CON001				0.00*	1,500.00*	450.00*	1,950.00
	UTILITY LOCATION SURVEY	1.00	LS	0	1,500	450	1,950

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
CON001 CONTAMINATED SOIL DISPOS			1.00*	0.00*	0.00*	1.00
AL FROM TRENCHES	1.00	LS	1	0	0	1
CON001 1 IN. SCH. 80 PVC AIR IN			4.60*	5.20*	0.00*	9.80
JECTION PIPING	785.00	LF	3,611	4,082	0	7,693
CON001 1 IN. SCH. 40 PVC VEE PI			4.60*	5.20*	0.00*	9.80
PING	1,750.00	LF	8,050	9,100	0	17,150
CON001			1.00*	0.00*	0.00*	1.00
PIPING INSTALLATION	2,940.00	LF	2,940	0	0	2,940
CON001 ONSITE CONTAMINATED SOIL			1.00*	0.00*	0.00*	1.00
TEMPORARY STORAGE	1.00	LS	1	0	0	1
CON001 CLAY LINER, 2' THICK FOR			8.30*	4.62*	1.34*	14.26
VEE AND AAS	150.00	SY	1,245	693	201	2,139
SUBTOTAL-GROUP TR			16,980	16,175	651	33,806
TOTAL FOR GROUP TR			23,160	22,063	888	46,111
TOTAL INCL OVERHEAD TR			23,160	22,063	888	46,111

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WD TRENCHING AND PIPING

	QUAN	U/M	MUP/ EXT	LUP/ EXT	EUP/ EXT	TOTAL
CON003			7.00*	0.00*	0.00*	7.00
BENTONITE SEAL IN WELLS	14.00	LF	98	0	0	98
CON003 INVESTIGATIVE WASTE DISP			500.00*	0.00*	0.00*	500.00
OSAL	7.00	LS	3,500	0	0	3,500
CON003			12.00*	0.00*	0.00*	12.00
SAND PACK FOR WELLS	120.00	LF	1,440	0	0	1,440
CON003 HALLOW STEM AUGER BORE H			28.00*	0.00*	0.00*	28.00
OLE ADVANCEMENT	150.00	LF	4,200	0	0	4,200
CON003 GROUT INSTALLATION IN WE			5.00*	0.00*	0.00*	5.00
LLS	100.00	LF	500	0	0	500
CON003			0.00*	0.00*	2,400.00*	2,400.00
DRILLIER MOBIOIZATION	1.00	LS	0	0	2,400	2,400
SUBTOTAL-GROUP WD			9,738	0	2,400	12,138
TOTAL FOR GROUP WD			13,283	0	3,274	16,556
TOTAL INCL OVERHEAD WD			13,283	0	3,274	16,556

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